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See Advertisement, page 27. 1879

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Cylinders 11 in. and 20 in. by 30 in. stroke.
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THOMAS MITCHELL & SONS, LTD.
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See Advertisement page 52, Oct. 31. 2402

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P. & W. MacLellan, Ltd.,
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MANUFACTURERS OF
RAILWAY CARRIAGES AND WAGONS OF EVERY DESCRIPTION.
RAILWAY IRONWORK, BRIDGES, ROOFING, &c.
Chief Offices: 129, Trongate, Glasgow. Od 3547
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The Manchester Steam Users' ASSOCIATION.
For the prevention of Steam Boiler Explosions and for the attainment of Economy in the Application of Steam. 9, MOUNT STREET, MANCHESTER.
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TENDERS.

THE GREAT INDIAN PENINSULA RAILWAY COMPANY of 45, COPTHALL AVENUE, LONDON, E.C.2, invite

Tenders for :—

1. VOLUTE SPRINGS ... ... Fee 2/6

Tenders are due by Eleven a.m. on 18th November, 1924. Tender Forms obtainable at above address. Fees not returnable. G 335

TO ENGINEERS, MACHINERY MERCHANTS AND OTHERS.

For Sale, by Private Bargain, the COMPLETE MACHINE TOOL EQUIPMENT of WALLACE (Glasgow), LIMITED, Engineers, Cardonald, Glasgow.

The Machine Shop, which covers several acres, was completely equipped with Up-to-Date Machine Tools in 1920.

Offers for the whole or part will be received by the Subscribers up till Twelve o'clock Noon on Friday the 14th day of November, 1924, who will supply fully descriptive Catalogues and Forms and Conditions of Tender, together with Cards to View.

ALEXANDER MURDOCH, C.A.,
53, Bothwell Street,
Glasgow.

JAMES WINNING, C.A.,
93, West George Street,
Glasgow,
Liquidators.

24th October, 1924. G 228

EBER ROBINSON & CO., LIMITED.

EXCELSIOR MACHINE TOOL WORKS, RIDDLESDEN, KEIGHLEY (Yorks.).

(In Voluntary Liquidation.)

For Sale by Tender as a Going Concern, the ASSETS and GOODWILL of the above BUSINESS. The assets comprise Freehold Land and Buildings, Lathes, Drills, Motors and all usual accessories for carrying on the work of the above Firm in the making of Special Machines for the Bobbin and Woodworking Trades. Letters Patent, Designs, Drawings, Patterns, Stock-in-Trade, etc., are included in and among the assets.

Applications to view, and offers, to be made to the undersigned not later than the 22nd day of November, 1924.

STANLEY LAYCOCK,
Barclay's Bank Chambers,
North Street, Keighley,
Incorporated Accountant,
HARVEY RATCLIFFE,
Craven Bank Chambers,
North Street, Keighley,
Corporate Accountant,
} Joint Liquidators.

G 287

STATE ELECTRICITY COMMISSION OF VICTORIA,
Melbourne,
Victoria,
AUSTRALIA.

Tenders are Hereby Invited for the SUPPLY, DELIVERY, etc., of the following for the Yallourn Power Scheme.

Copies of Tender Form and Specification will be available on application to :—

AGENT GENERAL FOR VICTORIA,
Melbourne Place, Strand,
London, W.C.2.

SPECIFICATION No. 25/1—6,600 V. TRANSFORMERS AND SPARES.

CHARGE :—£1 1s. for the first three copies of Tender Form, Conditions of Contract, and Specification complete. This charge will be returned on receipt of a *bona fide* Tender. A fourth copy and any further copies will be supplied for the sum of 5s. each. This charge is not returnable.

PRELIMINARY DEPOSIT :—A Preliminary Deposit of £50 is to be lodged with Tender.

The Specifications may be inspected at the above mentioned office.

The Commission does not bind itself to accept the lowest or any Tender.

Tenders on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than Five p.m., 15th January, 1925.

R. LIDDELOW,
Secretary. G 331

HIGH CARLEY SANATORIUM, near ULVERSTON.

For Sale, Vertical Boiler.

OFFERS are REQUIRED for a VERTICAL BOILER, size 10 ft. 6 in. by 3 ft. 6 in. Working pressure insured at 80 lbs per square inch. The boiler can be seen on application to the Medical Superintendent.

Offers to be sent to DR. G. LISSANT COX, Central Tuberculosis Officer, County Offices, Preston. G 244

THE GUARDIANS OF THE POOR OF THE PARISH OF LAMBETH Hereby Invite

Tenders for Supplying an ELECTRICALLY-DRIVEN HYDRO EXTRACTOR to their Lambeth Hospital.

General description of machine required together with Form of Tender may be obtained from this Office. Tenders are returnable on or before Tuesday the 18th November, 1924. The Guardians do not pledge themselves to accept the lowest or any Tender.

By Order,
JAMES L. GOLDSPINK,
Clerk to the Guardians.

Guardians' Offices,
128, Brook Street, Kennington, S.E.11.
3rd November, 1924. G 318

ADMINISTRATIVE COUNTY OF LONDON.

NORTH WESTERN STORM RELIEF SEWER.

CONTRACT No. 1.

The London County Council invites

Tenders for the Construction of a 9 ft. 6 in. Internal Diameter SEWER in Cast Iron with Concrete Lining, of a total length of about 9695 feet, from Clarendon Road, Kensington, to and including an outlet into the River Thames near Hammersmith Bridge, also a 6 ft. 0 in. Internal Diameter SEWER in Cast Iron with Concrete Lining of a total length of about 2375 feet, from King Street, Hammersmith, to the Council's pumping station at St. James Street, Hammersmith, all in the Boroughs of Kensington and Hammersmith. The work also comprises Flap Chambers, Penstock Chamber, Weir Chamber, Tumbling Bays, etc.

Persons desiring to submit Tenders may obtain the Form of Tender and Contract, Specification, Bill of Quantities and Drawings on application on and after Monday, 10th November, 1924, to the Chief Engineer of the Council at the Old County Hall, Spring Gardens, S.W.1, upon payment of the sum of £10, which amount will be returnable only if the Tenderer shall have sent in a *bona-fide* Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the contract documents may be inspected before the payment of the fee.

No Tender received by the Clerk of the Council after Twelve noon on 2nd December, 1924, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD,
Clerk of the London County Council.
G 314

STATE ELECTRICITY COMMISSION OF VICTORIA.
Melbourne,
Victoria,
AUSTRALIA.

Tenders are Hereby Invited for the SUPPLY, DELIVERY, etc., of the following for the Yallourn Power Scheme.

Copies of Tender Form and Specification will be available upon application to :—

AGENT GENERAL FOR VICTORIA,
Melbourne Place, Strand,
London, W.C.2.

SPECIFICATION No. 24/114—SWITCHGEAR AND ACCESSORIES.

CHARGE :—£2 2s. for the first three copies of Tender Form, Conditions of Contract, Specification and Drawings complete. This charge will be returned on receipt of a *bona fide* Tender. A fourth copy and any further copies will be supplied for the sum of 10s. 6d. each. This charge is not returnable.

PRELIMINARY DEPOSIT :—A Preliminary Deposit of £100 is to be lodged with Tender.

The Specification may be inspected at the above mentioned office.

The Commission does not bind itself to accept the lowest or any Tender.

Tenders on prescribed form, properly endorsed and addressed must be delivered to the undersigned in Melbourne not later than Noon, 12th January, 1925.

R. LIDDELOW,
Secretary. G 179

PORT OF BRISTOL.

THREE 9-TON STEAM CRANES FOR GRABBING.

The Docks Committee invite

Tenders for the Construction of THREE 9-TON STEAM CRANES for Grabbing. The contract includes the erection of the cranes on a Grab Hopper Dredger now in course of construction.

On and after Monday the 3rd day of November, 1924, copies of the specification etc., can be obtained from the undersigned on production of a receipt to the undersigned showing that a deposit of £5 has been paid to the BRISTOL DOCKS COMMITTEE, TO WHOM ALL CHEQUES MUST BE SENT AND MADE PAYABLE. The deposit will be returned to *bona fide* tenderers after the receipt of the Tender with all the prescribed documents and drawings.

The Tenders must be enclosed in a sealed envelope endorsed "Tender for Steam Cranes" and addressed to the General Manager and Secretary of the Bristol Docks Committee, 18, Queen Square, Bristol, and must be delivered to him accompanied by all the prescribed documents and drawings before Ten a.m. on Monday, the 1st December, 1924.

The Docks Committee do not bind themselves to accept the lowest or any Tender.

THOMAS A. PEACE,
Chief Engineer.

Chief Engineer's Office
Avonmouth Dock,
Bristol.
28th October, 1924. G 295

The Director-General, India Store Department, Branch No. 16, Belvedere Road, Lambeth, S.E.1, REQUIRES :—

VACUUM AUTOMATIC BRAKE GEAR and RIGGING.

Tenders due on the 21st November, 1924.
Tender Forms obtainable from above. G 329

G. R.

GOVERNMENT SURPLUS
TRANSFORMERS
LYING AT H.M. FACTORY, GRETNA,
For Sale by Public Tender.

Owing to the urgency of clearing the area, we are offering FOR SALE BY TENDER a large number of TRANSFORMERS of all sizes up to 1000 K.V.A. 6300/440 VOLTS, 50 PERIODS.

TENDERS CLOSE ON 19TH NOVEMBER.

Particulars and Forms of Tender from GEORGE COHEN & ARMSTRONG DISPOSAL CORPORATION, Abbey House, 2, Victoria Street, Westminster, S.W. G 295

Tel. No. Victoria 8040-4 Telegrams: "Cohstrong, Sowest."

BOMBAY, BARODA & CENTRAL INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to noon on Friday, 21st November,

Tenders for the Supply of :— WHEELS & AXLES FOR WAGONS.

Tenders must be made on forms, copies of which, with Specification, can be obtained at these Offices on payment of 20/- each (which will not be returned). The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices : 91, Petty France,
Westminster,
S.W. 1.
5th November, 1924. G 336

BELFAST HARBOUR.

The BELFAST HARBOUR COMMISSIONERS are prepared to receive

Tenders for the Erection of a GOODS SHED, to be constructed mainly of Steel and Corrugated Iron, on the East side of the Dufferin Dock, Belfast, in accordance with Drawings which may be seen at the Office of the Harbour Engineer, Mr. T. S. GILBERT, M.Inst.C.E., from whom copies of the Specification of Works, Form of Tender, and any further information may be obtained.

Tenders, on the special Form provided for the purpose, should be addressed to the undersigned, and must be enclosed in a sealed envelope endorsed "TENDER FOR SHED, DUFFERIN DOCK," and delivered not later than WEDNESDAY, the 10th DECEMBER, 1924.

Alternative Tenders for Roofing the Shed with approved Asbestos Tiles in lieu of Corrugated Iron will be considered

The Commissioners do not bind themselves to accept the lowest or any Tender,

M. J. WATKINS,
General Manager & Secretary.

Harbour Office,
Belfast, 4th November, 1924. G 334

STATE ELECTRICITY COMMISSION OF VICTORIA,
Melbourne,
Victoria,
AUSTRALIA.

Tenders are Hereby Invited for the SUPPLY, DELIVERY etc., of the following for the Yallourn Power Scheme.

Copies of Tender Form and Specification will be available upon application to :—

AGENT GENERAL FOR VICTORIA,
Melbourne Place,
Strand,
LONDON, W.C. 2.

SPECIFICATION No. 25/2,
VOLTAGE REGULATING APPARATUS.

CHARGE :—
10s. for the first two copies of Tender Form, Conditions of Contract, and Specification complete. This charge will be returned on receipt of a *bona fide* Tender. A third copy and any further copies will be supplied for the sum of 5s. each. This charge is not returnable.

PRELIMINARY DEPOSIT :—
A Preliminary Deposit of £5 is to be lodged with Tender.

The Specifications may be inspected at the above mentioned Office.

The Commission does not bind itself to accept the lowest or any Tender.

Tenders on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than Five p.m. 19th January, 1925.

R. LIDDELOW,
Secretary. G 320

APPOINTMENTS OPEN

TECHNICAL COLLEGE, BRADFORD.

Applications are Invited for the APPOINTMENT of LECTURER in the Department of Civil Engineering, Architecture and Building.

An inclusive salary up to £425 (less the voluntary contribution of 5 per cent.) per annum will be paid to a candidate of suitable qualifications and experience. Candidates should possess a good degree in Civil Engineering, and have had practical experience in public works and buildings.

Full particulars of the appointment, and Forms of application, may be obtained from the Principal of the College, to whom the applications should be returned completed not later than 15th November, 1924.

N. L. FLEMING, Town Clerk. G 311

Junior Engineering Assistant REQUIRED, experienced in road and sewer construction and surveying.—Write, stating age, salary, experience, etc., BOX 40, E. ANDERSON & CO., 14, King William St., Strand, W.C.2. G 331

Shipyard Manager Wanted to take entire charge under general management; must have experience in estimating, designing and construction of merchant vessels. State age, experience (in detail) and salary expected. —Address, VESSELS, Wm. PORTEOUS & Co., Advertising Agents, Glasgow. G 326

Experienced and Energetic SALESMAN (Engineer) with good connections in industrial circles REQUIRED for the LONDON OFFICE of a large Swiss Engineering Firm, for pushing the sale of Steam Turbines, Compressors, Water Turbines, Pumps, Paper-making Machineries, etc.—Applications, stating age, full experience and qualifications and salary required, also enclosing photo and testimonials, should be addressed to BOX 190, c/o HOOPER & BATTY, Ltd., 15, Walbrook, London, E.C. 4. G 299

Traffic Manager Required for the GOVERNMENT RAILWAY of the FEDERATED MALAY STATES for three years, with prospect of the post becoming permanent and pensionable. Salary $1050 (dollars) per month, plus a strictly temporary cost of living allowance of 40 per cent. of salary in the case of a single man and 20 per cent. for married men. No income tax is at present payable in the Federated Malay States. Free passages provided, and, if married, for wife and children also, not exceeding four persons. Candidates, aged 37-40 years, should preferably have had experience in the Traffic Department of one of the British Railways.—Apply, by letter, not later than the 17th November, stating age and experience, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1, quoting M/13307 at head of letter. G 290

Superintendent of ACCOUNTS AND CORRESPONDENCE REQUIRED by the GOVERNMENT of HONG KONG for the PORT DEVELOPMENT DEPARTMENT, for three years' service with possible extension. Salary £600, rising to £700 a year, payable locally, in dollars, at the Government rate of exchange, at present fixed at 2s. to the dollar. In addition a strictly temporary exchange allowance is at present paid, amounting to 20 per cent. of salary. Free passage. Candidates, aged 30-35, should be qualified accountants with experience in keeping Engineering Contractor's accounts.—Apply at once, by letter, stating age and experience, and whether married or single, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1, quoting at head of application M/13208. *It is useless for candidates without the requisite experience to apply.* G 291

COUNTY BOROUGH OF BRIGHTON.

WATERWORKS DEPARTMENT.

APPOINTMENT OF ENGINEERING ASSISTANT.

The Council invite

Applications for the Appoint- ment of ENGINEERING ASSISTANT in the Waterworks Department at a salary of £400 per annum; the appointment to be for a period of three years in the first instance.

Applicants, who should have passed the Associate Membership examination of the Institution of Civil Engineers, must have considerable experience in the design and layout of modern pumping plants, buildings, service reservoirs and mains, and preference will be given to candidates who have had a mechanical training.

Applications, in the candidate's handwriting, stating age, training, experience, qualifications, and present occupation, together with copies of three recent testimonials, should be forwarded to the undersigned, endorsed "Engineering Assistant, Waterworks Department," not later than 22nd November, 1924.

Further information as to the appointment may be obtained from Mr. A. B. CATHCART, M.Inst.C.E., Waterworks Engineer, 12, Bond Street, Brighton.

JAS. R. ROTHWELL, C.B.E.,
Town Clerk.

Town Hall, Brighton.
4th November, 1924. G 313

CITY OF BIRMINGHAM EDUCATION COMMITTEE.

MUNICIPAL TECHNICAL SCHOOL.

HEAD OF ENGINEERING DEPARTMENT.

The Education Committee invite

Applications for Appoint- ment to the POST of HEAD of the ENGINEERING DEPARTMENT of the Municipal Technical School. The post is a full-time one and the salary scale is £350 per annum, rising, subject to satisfactory service, by annual increments of £30 to £500 per annum.

The above-mentioned salary will be subject to a deduction of 5 per cent. in respect of the voluntary abatement of salaries, and also to the usual deduction of 5 per cent. in respect of contributions to the School Teachers' (Superannuation) Acts.

Particulars of the duties and conditions of the appointment, together with form of application, may be obtained from the Principal, Municipal Technical School, Suffolk Street, Birmingham, or from the undersigned.

Canvassing will be a disqualification.

P. D. INNES,
Chief Education Officer,

Education Office,
Margaret Street,
Birmingham.
7th November, 1924. G 309

Sales Engineer.—Man with first-class technical commercial experience, to sell Aluminium Alloy Castings. Must have thorough acquaintance with Motor Car trade.—Write, stating full particulars and remuneration required. T.B. c/o J. W. VICKERS & Co., LTD., 5, Nicholas Lane, E.C.4. G 330

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Inspector of Works Required, experienced in Tunnel Construction under heavy air pressure. State age and salary required, and give full particulars of experience.—Address, G 332, Offices of ENGINEERING.

Engineers of all Nationalities REQUIRED for occasional translations from English.—Address fully, stating experience, G 265, Offices of ENGINEERING.

Electrical Engineering ASSISTANT REQUIRED, age 28-32, experienced in the design of all types of a.c. and d.c. motors and generators, prime movers, transformers, batteries, electro-magnets, switchboards and wireless transmitting gear. State Salary, age, experience and references.—Address, G 334, Offices of ENGINEERING.

Chemical-Engineer, with Sound commercial training, REQUIRED for White Lead and Lead Oxide Works, run electrically. —By letter (only), stating age, experience and salary required, to ROWE BROS. & CO., LTD., Pall Mall, Liverpool. G 298

Sales Engineer for Marine Oil Engines.—WANTED FIRST-CLASS MAN to introduce to Shipbuilders &c., Engines by one of the largest firms of Oil Engine Manufacturers. State age, experience and salary required. No one unless possessed of good seagoing knowledge of the requirements in Marine Internal Combustion Engines and with Sales ability need apply.—Address, G 330, Offices of ENGINEERING.

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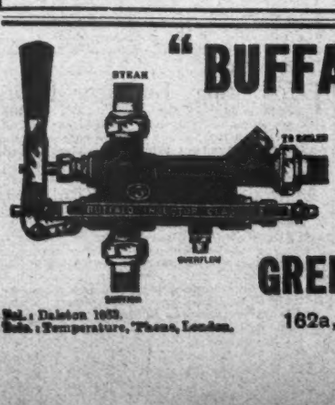

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LITERATURE.

The Natural History of Crystals. By A. E. H. Tutton, D.Sc., M.A., F.R.S. Illustrated. Kegan Paul, Trench, Trubner and Co., Limited, London and New York. 1924. [Price 15*s.* net.]

The author of this work reminds us that in 1911, he published a volume with a similar title and of similar purpose, presenting an account of some of the more important properties of crystals, geometrical, optical, and technical. The present volume has grown out of its predecessor, but since those days the outlook has broadened. The science of the atom has been born and has developed a vigorous growth, that dwarfs all recent claimants for public favour. The power of this newcomer to combine and to harmonise a host of intricate and baffling details seems illimitable and makes it one of the most beautiful conceptions of modern times. The atom invites us to pursue a new line of study, by substituting the individual for the aggregate. The chemist is familiar with the atom in the mass, but simply as a convenient unit, not dreaming of the energy within its tiny compass or the mechanism hidden in its minute girth. He has weighed it and tested it in various combinations and by various methods. He knows the proportions in which atoms combine with other atoms, and the conditions in which they refuse, but of the manner in which the individual atom worked he was ignorant. Till the science, or the romance, of radio-activity opened new avenues for investigation, this key to so many enigmas, was unsuspected. Now the services of this atom that has never been seen and never will be seen in the ordinary sense of the word, are requisitioned in every direction with feverish anxiety and perhaps in no branch of science more eagerly than in crystallography.

The science of crystallography has much to attract students, for it teaches how matter is formed and enables us to penetrate the details of its underlying structure, yet its many fascinations have been treated slightingly. Will this new interest of the atom offering a wider outlook have the power to attract greater attention and bring a larger number of workers on the field? Hitherto progress has been *per saltum* rather than uniform. Able teachers have exercised a personal influence and won short-lived success, but continuity has not been a marked feature in the history of the science. Dr. Tutton recognises that where development has been most manifest, success has been due to the energy of a small number of investigators, who have carried on researches in the true spirit of amateurs. He now hopes that the brilliant successes that have been achieved and the possession of more powerful means of experimental attack will attract new recruits to this science, which stands in such close relation to physics and chemistry, giving valuable assistance to both. It is with the view of increasing the number of students that he has prepared this work, which in many ways may be regarded as an introduction to his larger treatise "Crystals and practical Crystal Measurement," which we reviewed two years ago (vol. cxiv, page 21). We hope he may not be disappointed, but it is safe to say that crystallography has suffered from the want of elementary text-books, designed to make the path easy to the beginner. This is another way of saying that there is no class to be catered for and that there is no demand for such books, for if any large body of chemists or physicists were disposed to take up the subject, the necessary writers would be forthcoming. The author attributes some of the indifference to the controversies that marked the teaching of such rival schools as those of Haüy and Mitscherlich, for controversies always imply distrust and uncertainty; lack of confidence has doubtless acted as a restraint.

Unquestionably there is much to discourage the student who attempts to master the theory, and we cannot say that the author has exerted himself to smooth the way of the neophyte. The vocabulary is unfamiliar and forbidding, and this, the introduction of an excellent glossary endeavours to remedy. Professor Miller's method of labelling and distinguishing the various faces by a symbol involving the three axial ratios has much to recommend it to the expert, and is a triumph of ingenuity, but to the beginner it is perplexing and involves considerable strain. The fourteen space lattices of Bravais representing the possible arrangements of the grosser structural units in the crystal are a monument to his genius, but one would hardly grow enthusiastic over the geometry involved. Similarly the labours of Sohncke, that led to the discrimination and description of 65 regular point systems, or the homogeneous assemblage of points symmetrically and identically arranged about axes of symmetry, are not readily apprehended, though they may appeal to the initiated as establishing a satisfactory geometric theory of the homogeneous partitioning of space.

A difficulty of another kind faces the student when he begins to handle and study crystals. The great diversity of habit exhibited by crystals of the same substance seems at utter variance with the views he has acquired from the work of Haüy, who maintained the great law of the constancy of the angles of the crystals derived from the same source. Confronted with the rhombs of Iceland spar, with the scalenohedral dog-tooth spar, and with the long prismatic form of calcspar, terminated by rhombohedra, how is he to credit the statement that the angles between corresponding faces are always exactly the same. The author meets the difficulty fairly, as an experienced teacher would, but it is not easy to inspire confidence in the tyro till very considerable advance has been made in the science, and he has become familiar with the vagaries that growing crystals can assume owing to accidental conditions, occasioning unequal development of the various types of face. Crystals produced under known and controlled conditions do not exhibit such wild freaks, and in passing it should be said, that no one has done more than the author to place in the hands of students, both the instrumental means capable of giving accurate measurements, or to perfect the devices for procuring measurable crystals.

Much that was conjectured or accepted with hesitation has disappeared with the greater accuracy introduced. Further confirmation of accepted theories was perhaps not really needed, but it is nevertheless welcome. Dr. Tutton seems relieved that new methods of investigation have given to working hypotheses a more solid foundation, and that the laboriously constructed edifice, reared on the investigation of the external forms of crystals and their optical properties, has stood the most rigorous test without exhibiting weakness in any essential particular. Some of the ornamental excrescences attached to the main building have failed to withstand the strain, but the solid workmanship of many architects remains uninjured.

Prof. Laue of Munich started the research into the infinitely minute that has proved so fructiferous. To him we owe the suggestion that the extremely short X-rays might be capable of reflection by the planes of atoms within the crystal. Dr. Tutton has devoted no small portion of this work to explaining how the theory and known properties of the atom bear on the chemistry and physics of the crystal. It is a fascinating study presented in a very informing manner, and what a marvellous tale he unfolds. The main fact that just as a prism or diffraction grating makes known the constitution of white light, so every crystal enables us to see the most primitive grouping of atoms, and on the other hand, affords a direct revelation of its symmetry, has become generally known; but here are brought before us the groupings of the atoms in the diamond, the character of the displacement that converts the diamond into graphite, or the symmetrical groupings of the atoms in the structure of ice. The mechanism is everywhere seen in operation.

The scheme of enantiomorphism is put very clearly and the illustration of the principle exhibited most interestingly in certain types. The weird behaviour of tartaric acid, whose early history puzzled Biot and carries us back to the work of Pasteur, has perhaps still some secrets to reveal, for besides the curious structure of dextro- and lœvo-crystals of the acid, we learn that the spores of *Pencillium glaucum* have a marked preference for the dextro variety, leaving the lœvo variety unattacked till the dextro has disappeared. Dr. Tutton records the fact but offers no explanation. The puzzle is "why a living organism thus eats up by preference one variety only, possessing a particular right-or left-handed screw structure, of a compound containing the same elementary constituents chemically united in the same manner; this remains a most interesting biological mystery."

Another intriguing chapter is that on "liquid crystals," a term that is still written in inverted commas. Several of the properties of crystals are present, but hardness, the comparative hardness of ice or gypsum, is wanting. Prof. Lehmann who first described the phenomenon regards the formation as truly crystalline, and his later work has done much to remove the prejudices or distrust with which his original announcement was received, but the author, while dealing sympathetically with the claim, doubts whether they are true crystals. But he regards as incontrovertible the fact, that these flowing crystals are an indubitable experimental fact, though formed by a relatively few substances and these of a very complex molecular constitution.

Dr. Tutton has made us his debtor for a book as valuable as it is interesting. The illustrations are excellent and the style lucid. It offers a bridge whereby the educated may enter into the realm of the specialist, and it should be welcomed wherever learning is maintained and knowledge advanced.

The Principles of Irrigation Enginering with Special Reference to South Africa. By Francis Edgar Kanthack, C.M.G., M.Inst.C.E. London: Longmans, Green and Co. [Price 30*s.* net.]

The art of irrigation is as old as Homer, who wrote of the peasant bringing rills of water from the bubbling springs to his garden. Mr. Kanthack writes on the "Principles of Irrigation Engineering," bringing it into the domain of science.

As rightly pointed out by Mr. Kanthack, the work of an irrigation engineer does not consist merely in constructing works, to divert the waters of a river on to the land, or for storing the waters and using it for the same purpose; but, apart from the necessary qualifications which enable him to do so, his study has to be directed to the water itself, as a floating vapour, its precipitation, its evaporation, its percolation into the soil, its flow in rivers and streams, and its discharge in floods. Again his study has to extend to the agricultural conditions of the tract of land to be irrigated, nature of soil, fitness for irrigation, and the seasons during which water is required; and, what is of the most importance, to investigate the financial possibilities of an irrigation scheme. Even here his work does not end, for in the distribution of the water the laws of the country regarding water rights have to be observed; so that an irrigation engineer has to combine the highly-specialised knowledge of hydraulic engineering with that of an administrator. It is not necessary that an irrigation engineer should have the knowledge of a geologist, or an agricultural chemist, or that of a practical farmer; but his wide field of education and experience should enable him to utilise the advice of practical experts in working out his schemes; and the best of this advice can only be obtained by cultivating the social amenities of life. As Mr. Kanthack states, no branch of civil engineering offers more scope for the study of difficult problems, many of which are yet unsolved, and to a large extent imperfectly understood, or offers more scope for research on a big scale, than that of irrigation.

The chapters on "Rainfall and Flow Off the Ground Due to the Rain Falling on It" deal entirely with climatic conditions obtaining in South Africa. Sir Alexander Binnie's rule is discussed, and the fact that to obtain a satisfactory mean rainfall of a locality, a record of at least thirty-five years is necessary, and that there are no means of framing a seasonal forecast applicable to the country, has been exemplified in the case of South Africa—particularly in the great plateau area of the Union, which obtains practically the whole of its rainfall from scattered thunderstorms. The great difficulty in estimating the yield or run-off from the rain falling on this karoo area is that the run off depends entirely on the intensity, or manner, in which the rain falls, and the condition of the area during the period of the rainfall. Typical annual run-off curves for various catchments in South Africa are given. It is gratifying that a Hydrographic Branch of the Irrigation Department of South Africa has been established.

The chapter on high floods and disposal of surplus

water from reservoirs, calls for no remarks. The question of the storage capacity of a reservoir between the full reservoir level and the maximum water level permitted, producing a considerable equalising effect on the "flood discharge" to be provided for, has been considered by irrigation engineers for a long time.

The chapter on reservoir and canal losses does not give records of losses in South African canals; the author quotes figures from records made in the canals of the Punjab; but these figures cannot be applied to the whole of India. In the irrigation canals of the Godavery and the Kistna deltas, which are composed of black alluvial clay soil, after the cracks formed during the hot dry weather have closed up, the loss by percolation is very small indeed. Compared with the soils of the Godavery and the Kistna deltas the Punjab soils would be regarded as a filtering medium. More experience seems necessary before a pronouncement can be made regarding the advantage of lining canals. The main consideration is its cost, and this has to be weighed against the actual advantages gained. Irrigation schemes in South Africa are handicapped by the high cost of skilled labour, and the difficulties and cost of transport; and this applies more particularly when the question of storage has to be considered.

In the chapter dealing with silt, Mr. Kanthack does not distinguish between the fine particles of clay carried in suspension, which render the water turbid and which are only deposited in still water, and the sands of various grades which are carried along in the lower depths of a canal or rolled along its bed, and are deposited when the velocity in the canal is not able to carry them forward. It is the latter class of silt that causes the trouble in the canals. The deposit of the particles of clay, which are carried in suspension, on to the land is beneficial, as it renews the soil; while the deposit of the sand which is carried down the canals on to the land is harmful. The author has not mentioned Dr. Deacon's, Mr. Thrupp's or Mr. Seddon's experiments on the movement of sand, and the transporting power of water. Also in view of the Report of the Indus River Commission, and of Mr. Buckley's experiments in Egypt, the statement made by Mr. Kanthack that with the same cross section and depth of flow, the velocity, and consequent discharge will be greater when the water is clear than in the case when the water is charged with silt, cannot be accepted as correct.

More observations are necessary before any pronouncement can be made as to the sitting up of reservoirs—the rate will vary with the nature of the basin drained and the transporting power of the stream or river feeding the reservoir. The same remarks apply to the scouring of reservoirs by sluices in the reservoir dam. The clayey substance may be easily eroded, but if the river or stream were to bring down large quantities of sand, particularly if the sand be derived from a granite formation, the scouring action of these sluices may be only local.

In the chapter on the Duty of Water, Mr. Kanthack is right in stating that for economy and for a stable canal regime the supply down the main canal, and its main branches should be constant during the period of irrigation; the rotation for the crops can be made in the distributaries. Another point for consideration which has been neglected by him is that the land, to be classed as irrigable by the irrigation project or scheme, should be at such a level that it is easily commanded by the water flowing in the minor distributaries. Where water has to be raised by temporary dams across a canal or distributary so as to enable it to flow on to the land to be irrigated, economy of distribution, and the maintenance of a stable regime of a canal are severely handicapped. It is advisable to read this chapter on the Duty of Water in conjunction with the paragraph on Methods of Distribution in the next chapter (see p. 261). The labour and plant available for agricultural operations largely influence the time required to cover any extent of land with water.

The chapter on "Brak" or the injurious effect of certain salts on the land when they become concentrated requires careful perusal; pointing to the necessity of preventing stagnation of water and of efficient drainage. An important consideration is that in the drier parts of South Africa prolonged storage is detrimental, due to the excessive evaporation producing a concentration of salts in the water remaining in the reservoir, thus rendering it unfit for irrigation.

The chapter on Irrigation Law applies only to conditions obtaining in South Africa, but it points to the dangers and difficulties that may arise when the laws of one country are applied to another where conditions are totally different.

Mr. Kanthack has not dealt with the effect irrigation on public health.

The book treats entirely of conditions obtaining in South Africa, and its usefulness in that respect would be increased if more details of irrigation works actually carried out in South Africa were given. The author gives reference to many technical papers of the Government of India which are not available to civil engineers who are not members of the Indian Public Works Department.

THE TIRSO DAM, SARDINIA.

SARDINIA, which is the second largest island in the Mediterranean, has considerable natural resources, but these have not been developed to any great extent. The island, being situated between Italy and Spain in one direction, and between France and her African possessions in the other, occupies a most advantageous position from the geographical point of view. It is not, however, well furnished with harbours, practically the only one of importance being Cagliari, situated in the extreme south and in proximity to the district of Iglesiente, a tract of country abounding in mineral wealth. Even this harbour is ill equipped. It has neither dry dock nor coal storage of any extent, and is not as yet even served by mechanically-operated cranes. The mines of the country, including those of the Iglesiente district, form a valuable asset. The mining industry is almost wholly in the hands of foreigners. The minerals are mostly exported in the raw state and the industry, therefore, only benefits local labour to the extent of the wages paid to the 15,000 hands employed in it.

The mountainous districts of the island were formerly covered by extensive forests, which, however, have long since almost completely disappeared. This destruction has had a considerable effect on the hydrology of the island, which in course of time has been quite changed. There are now practically no rivers with any regular flow; but torrents of great violence occur in the rainy season, dwindling to such an extent in the summer months that flow ceases in the channels. The larger rivers are shown in Fig. 1 opposite, the first in importance being the Tirso, which drains an area of about 800 sq. miles. The higher parts of this area being semi-arid, the flow fluctuates enormously, varying from a maximum of 1,000 cub. metres per second (35,320 cub. ft. per second) after heavy rainstorms in winter, to practically nothing. The average available discharge is about 706 cub. ft. per second.

Some years ago the Italian Government decided upon the development of irrigation in the island by regulating the flow of the rivers in the more promising instances and passed the necessary measures for carrying out such work. The schemes included the construction of artificial impounding reservoirs at various points. The scheme formulated in connection with the Tirso involved the construction of a dam, impounding water to form the lake shown in Fig. 2. The Tirso scheme is notable for many reasons. The whole project involves the regulation of the river and conservation of water for irrigation purposes, the production of hydro-electric power, and, further, the drainage of a large area to be served by irrigation. It is moreover of special interest to engineers as it includes what is to date the highest and most important example of a multiple arch dam to be built, an advance with a type which, in the opinion of many, is considered as likely to have far-reaching effects on future dam design. This dam was recently completed and on April 27 last was formally inaugurated by H.M. the King of Italy. This imposing structure is illustrated in Figs. 3 to 16, on pages 633 to 635, and on Plates LXV to LXVIII, which accompany this week's issue of ENGINEERING.

The reservoir formed has a surface area of about 8·5 square miles, and a maximum storage capacity of 416 million cubic metres (14,700 million cub. ft.) The generation of power will amount normally to 10,000 h.p., with a peak capacity up to 30,000 h.p. This power will be utilised chiefly in the zinc and lead mining districts to which transmission lines will be carried. Sardinia will thus be in a position to export metals and manufactured products instead of only crude ores. The area which will be capable of irrigation under the scheme surrounds Oristano, and is shown in Fig. 2. It amounts to some 70,000 acres, of which 12,000 are of a swampy character and require to be drained before they can be completely brought under crop.

The scheme of building a multiple arch dam on the Tirso river was first put forward in 1912 by Engineer Angelo Omodeo and superseded an earlier scheme on a smaller scale. The work on the dam, officially known as the Santa Chiara di Ula dam, was commenced under the supervision of Engineer Luigi Kambo in 1917. The project is being carried out by an important financial group, the concessionaires being the Imprese Idrauliche ed Elettriche del Tirso (Banca Commerciale, Meridionala Vickers, Limited). The complete programme of the Imprese Idrauliche ed Elettriche del Tirso includes a second development on the Tirso which will yield 12 million kw.-hour per annum; the development of the fall of the River Coghinas in the north of the island, capable of 90 million kw.-hour per annum, and the utilisation of the fall of the River Flumendosa in the southern part of the island, with a possible yield of 120 million kw.-hour per annum. The present Tirso scheme being capable of giving 50,000,000 kw.-hour per annum, the whole programme will result in the production of about 270 million kw.-hour per annum.

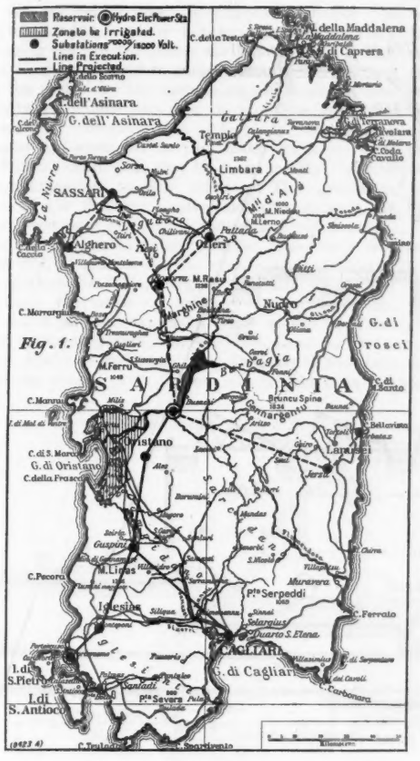
The first part of the programme, now so well advanced, comprises the transmission of electrical energy over the routes marked in heavy black lines in Fig. 1. The bulk of the power will be sent to Cagliari, where it will be distributed by the Societá Elettrica Sarda, which has contracted for the whole output of 50,000,000 kw.-hour.

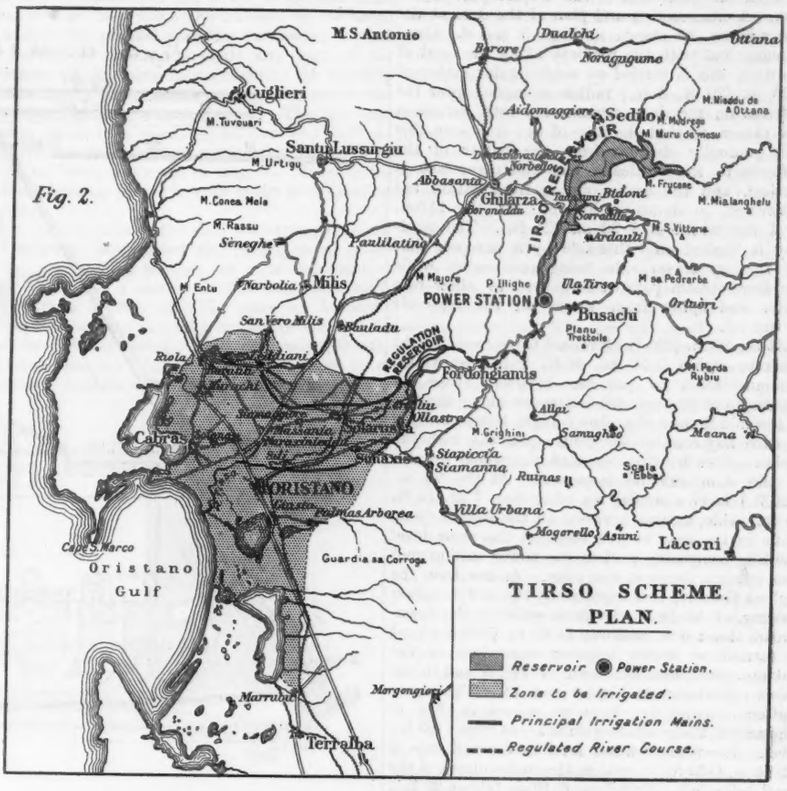
The dam impounding the water of the river, with the power station, is situated near the village of Busachi. At Villanova Truscheddu an automatic regulating weir is placed across the bed of the Tirso for regulating the water for the irrigation distribution channels. The Metropolitan-Vickers Electrical Company and its affiliated Italian company are supplying the electrical plant for the project.

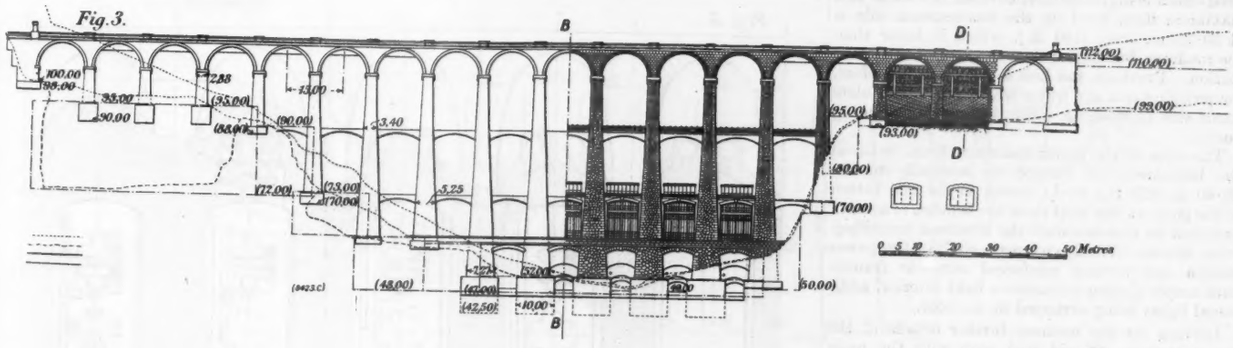
The multiple arch design was, it is understood, adopted partly on account of economy—the saving in cost over a gravity section dam being placed at 20,000,000 lire—and partly because this type was considered safer from the point of view of temperature cracks, in such a region as that in question in this instance, with lowest temperatures occurring during the period of high water.

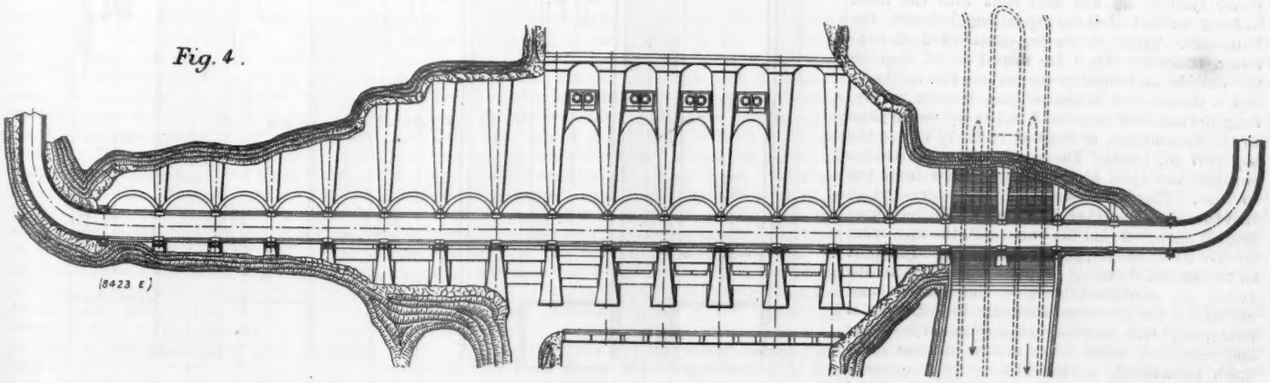
The dam consists of a series of seventeen arches, as shown in Figs. 3 and 4, with 15 metres (about 50 ft.) between the centres of the piers. The total length of the structure from centre to centre of the end piers is 255 m. (509 ft.); two of the bays are fitted with regulating sluice gates. One of the most notable points about the dam is its great height, namely, 69·5 m. (228 ft.) from the lowest foundation level to roadway level along the top. The piers or buttresses are of massive masonry, a class of construction in which, of course, the Italians are experts, practically without equals. The arches are of reinforced concrete. The buttresses have face slopes of 70° 40′ on the downstream side, and 57 deg. for the upstream slope (see Fig. 5). The latter is a departure from the more usual 45 deg. or 50 deg. The length of the buttresses, transversely to the axis of the dam, varies according to the position. At the 110 metre level (361 ft. elevation) they have a length of 5 m. (16 ft. 5 in.), while the greatest length at the base of the dam at the 49 m. level, (160 ft.) that is, the elevation of thei nvert of the discharge culvert, is 66 m. (216 ft. 6 in.). The actual length of the buttresses at the upper level is

THE TIRSO HYDRO-ELECTRIC SCHEME IN SARDINIA









increased as we shall point out later, for the accommodation of a high level roadway 6 m. wide between parapets. In width the buttresses increase from 2·50 m. (8·2 ft.) at the highest level to 7 m. (23 ft.) at the 52 m. (170 ft.) level: at this point the piers are increased to a thickness of 10 m. (32 ft. 10 in.), which is then maintained to the lowest point of the foundations—in the case of the five largest piers, at 42·5 m. elevation.

The buttresses are built of rough pointed masonry of red trachyte, faced with ashlar. The courses are for the most part horizontal, except in the pressure zone in the down stream part, where they are laid normal to the line of pressure, as will be seen in Figs. 8 and 14, Plates LXV and LXVIII, and also Fig. 5.

The buttresses are tied together at four levels, viz., by the line of arches carrying the high level roadway, and at two other levels (73 m. and 90 m. elevation) by light flying arches, while at the foot they are interstayed by arches carrying a low level

roadway, at 61 m. (200 ft.) elevation, and by the floor of the power house structure, which is arranged between the buttresses at the deepest part of the dam. A cross-section and plan of the dam at the power house are shown in Figs. 5 and 6. Commencing first with the roadway along the crest of the dam, this is carried on semi-circular arches of 6·25 m. (20 ft. 6 in.) radius springing from the buttress on the down-stream side with curves in two planes, so that the face of the arches on this side gradually changes from the batter of the buttress to the vertical. The up-stream face is vertical, and the arches spring from within the buttresses, as shown in Fig. 5. At the 112-m. level the width is 7·30 m. (24 ft.). The roadway is flanked on either side by a parapet, that on the up-stream side being continuous, while the down-stream parapet is pierced to allow rain water and spray from waves on the reservoir to run off.

At the 90 m. (295 ft.) level are three rows of light concrete arches 2·50 m. (8 ft. 2 in.) in width. Communication is possible between these by openings cut through the buttresses along the line of the middle row of arches. Light lattice bridges in each bay connect the centre pathway with the arches on either side, so that the whole interior of the dam can be inspected. At the 70 m. (229 ft.) level a similar set of arches, 3 m. (9 ft. 10 in.) wide, extend between all the deeper piers, while in the case of five bays, at the same level vaulting composing part of the power station roof also extends between the piers. At the base the highest piers are tied together by the power-station flooring, at 58·10 m. elevation, while on the down-stream side a 6 m. roadway at 61 m. (200 ft.) level is carried on arches between extensions of the buttress structures, as shown in Fig. 5 and in the views reproduced in Figs. 8 and 14. The power station occupies five bays, as shown in Fig. 6. The axes of the generating units are at 59 m. (193 ft.) level. The normal water level in the tail race is 52·60 m. (170 ft.) elevation, the suction head of the draft-tubes being, therefore, 6·40 m. (about 23 ft.). Maximum flood level on the down-stream side is at 59·75 m. level (196 ft.), which is lower than the roadway, but higher than the floor of the power station. Provision has had to be made, therefore, for pumping out any water which may accumulate inside due to washing down, leakage, &c., during floods.

The sides of the power station sections, between the buttresses, are carried up vertically to the 68·40 m. (224 ft.) level; owing to the side batten of the piers, at this level there are benches of a width sufficient to accommodate the overhead travelling-crane tracks. The down stream walls of the power station are vertical reinforced concrete frames, with ample glazing to ensure a light interior, additional lights being arranged in the roof.

Leaving for the moment further details of the power station, we will deal next with the main inclined arched decking spanning between the buttresses. These arches are constructed of reinforced concrete. They are sloped to 57 deg. on the outside and slightly steeper on the inside to suit a decrease in thickness from bottom to top, ranging from 1·67 m. (5 ft. 6 in.) at the crown close to the foundations, to 0·50 m. (1 ft. 7¾ in.) at the top (107 m. level). The width of the buttresses varying, the span of the arches varies from top to base. The radius is at all places arranged so that the rise is one-third of the span. The reinforcement is anchored into the buttresses, the up-stream faces of which are stepped so as to give good support to the arched decking. For the highest 10 m. the arches are reinforced both on the intrados and extrados; for the remainder only the extrados is reinforced, with longitudinal and transverse bars and expanded metal. The arches in most cases finish horizontally at the 110 m. level, a heavy coping being added for stiffness and with the object of throwing back the waves, thus protecting the open upper ends. At the five bays forming the power station these upper ends are decked in as shown in Fig. 5. At the bottom the inclined arches finish in a curtain wall, carried about 2 m. into impervious rock. This is carried across the valley. On the up-stream face reinforced concrete slab-work

POWER STATION OF THE TIRSO SCHEME, SARDINIA.

Fig. 5. SECTION B.B (Fig. 3.)

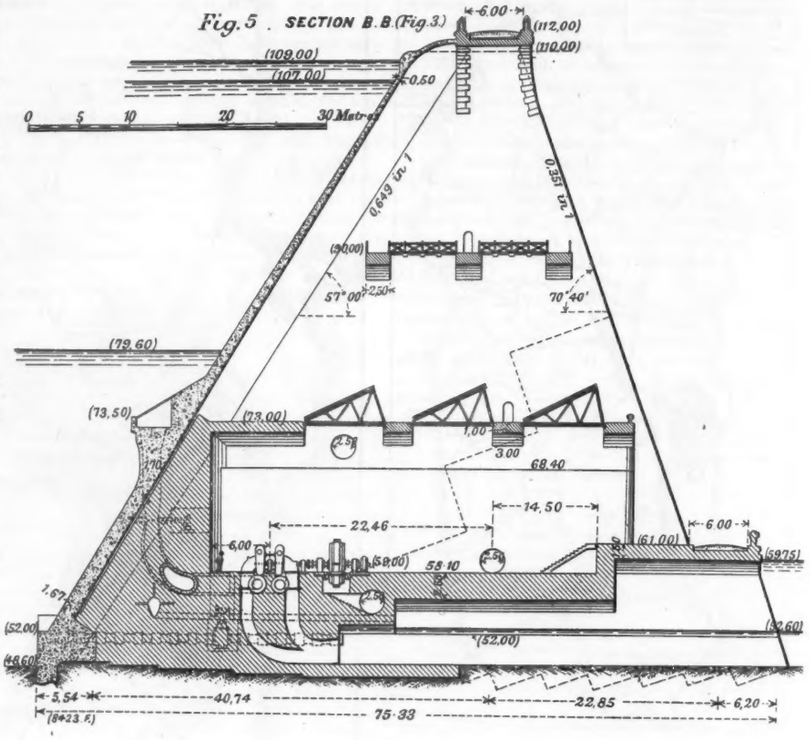
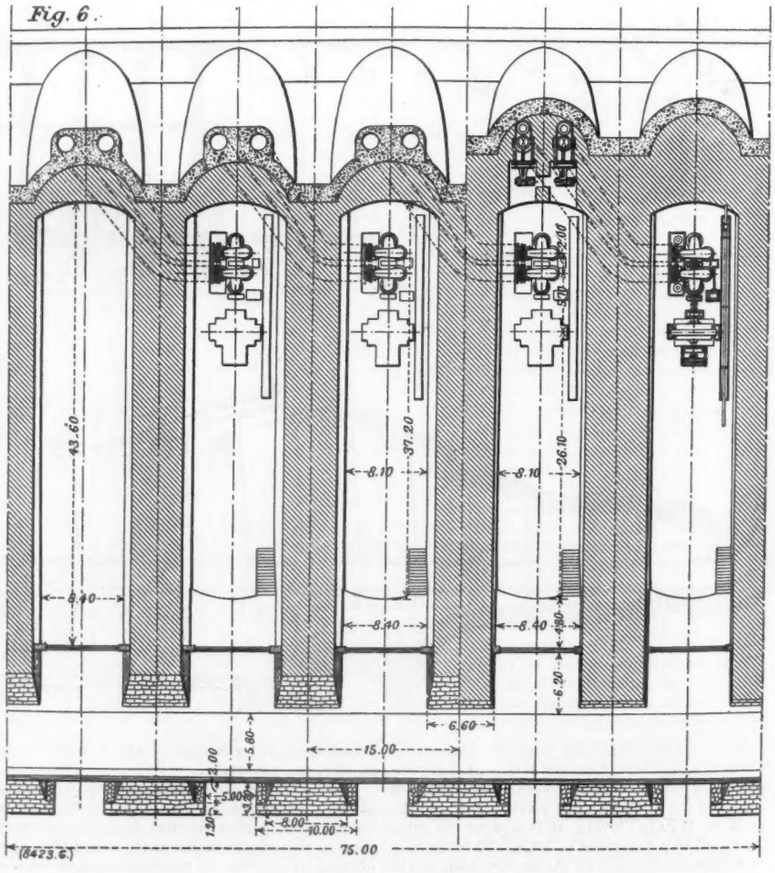


Fig. 6.



extends between the arches, anchored into the buttresses.

The arched decking is supported below the 73 m. (239 ft.) level by a heavy mass of masonry forming part of the power station structure. This has been introduced to compensate for the piercing of the arches by the turbine supply conduits, and partly to reduce the risk of vibration from the machinery affecting the structure. Intercepting drains are arranged in this mass, while an oval collecting drain will also be seen in Fig. 5, with communication to the tailrace. The up-stream face of the decking is overlaid with asphalt for the lower part and with gunite and water-proofing for the part which may be alternately wet and dry, above the 73 m. level. Figs. 5 and 6 show that the turbine supply conduits are carried through the mass of masonry just referred to, off-set so as to avoid sharp bends at the turbines. The generating sets are, perforce, arranged with their shafts at right angles to the axis of the dam and the supply pipes for one set are led from the arch work. The draft tubes are carried through the masonry foundation of the power house and combine, just as they reach the tailrace, to discharge in a direction parallel with the buttresses, so that no current is directed towards any part of the structure which assists in maintaining the stability of the dam. The tailrace passages between the buttresses have a width of 5 m. The drainage system opens into these, as do also two 0·95 m. (3 ft.) diameter scour pipes carried through the dam at 52 m. level, as shown in Fig. 5. Valves controlling these are placed in wells in the power station flooring.

Two of the bays of the dam are arranged to act as a spillway, being fitted with hinged sector gates. These bays will be seen at the right-hand end of Figs. 3 and 4. A section at this adjustable spillway is given in Fig. 15. The gates can be hand-controlled, but are normally automatic and set to work at a certain level. They will pass 800 cub. metres per second. In addition, there are two gate-controlled tunnels with inverts at 73 metres elevation. These will discharge another 800 cub. metres per second. The view given in Fig. 12 shows, on the far bank, the two levels at which these discharges are allowed to escape past the dam to the down stream channel. The total discharge with the turbines operating can be maintained at 2,000 cub. metres per second (70,630 cub. ft. per second), equivalent to about 1 cub. metre per second per square kilometre of drainage area. The lower discharge tunnels enable the reservoir level to be kept at any desired elevation, while they also made it possible for the power station to be put into operation at an early stage of construction, as, when the dam was completed to 73 metres elevation these tunnels acted as overflows and further construction proceeded while power was being generated.

The power station will ultimately be equipped with two twin-runner inward-flow horizontal turbines, each of 6,000 brake horse-power, coupled direct to three-phase alternating current generators (with direct-coupled exciter), producing current at 5,000 volts. Two further 9,000 h.p. sets of similar design will also be installed to complete the scheme, while a 60 h.p. auxiliary turbine set supplies current required at the station. The average head utilised will be about 46 metres. Current will be transformed up to 75,000 volts for transmission. The transformers are arranged in a separate bay provided with seven floors with communication by lift between them. The various sections of the power-house communicate with each other by means of circular openings in the buttresses 2·50 metres in diameter.

As regards construction, cement mortar has been used throughout. Headers and stretchers were carefully proportioned in the buttresses, and, in addition, cross bars of iron to the rate of one for every 3 sq. m. have been inserted. The design provided for a maximum stress in the buttresses of 13·5 kg. per sq. cm. (192 lb. per sq. in.). Tests of the mortar gave results of 190 and 280 kg. per sq. cm. (2,700 lb. to 3,980 lb. per sq. in.) after 180 days. The stone, trachyte, obtained locally, had a crushing strength of 800 kg. per sq. cm. (11,380 lb. per sq. in.), and the rock foundation gave results about the same. The site was excellent from the point of view of foundations except at one point. For the greater part solid trachyte was found under porous tufaceous rock. Unreliable surface strata had to be removed at one point to a depth of 12 m. at the down stream toe of the dam. Towards one of the wings unreliable material was found inside a pocket indicated in Fig. 3. Here a concrete cut-off wall was carried down to 72·0 m. elevation. Construction was commenced during the war, but proceeded at a slow rate only till the termination of hostilities.

Fig. 16 indicates the construction organisation. The construction plant included an aerial cable way, of 7 tons capacity, spanning the site. Rock was quarried nearby on one bank and dressed or supplied to a crushing plant. Several inclined rope railways were installed, as well as all the necessary pumping, boring and compressing, concrete mixing and other plant. A cement gun and pressure grouting apparatus were also employed. The four views, Figs. 7 to 10, Plates LXV and LXVI, give a good idea of the work during construction. The two latter show a number of the points to which we have referred above. Both show the intake

Fig. 15. SECTION D.D. (Fig. 3.)

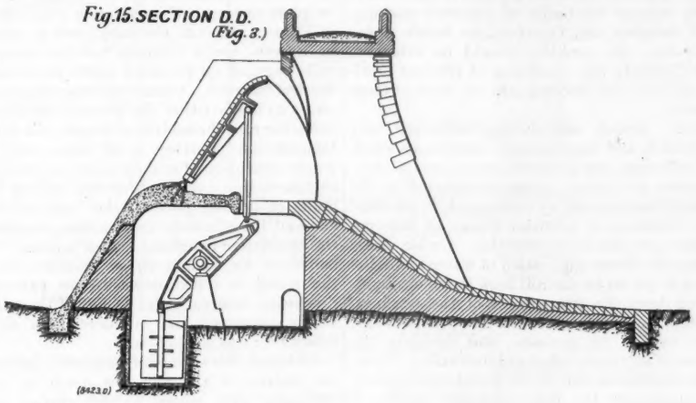
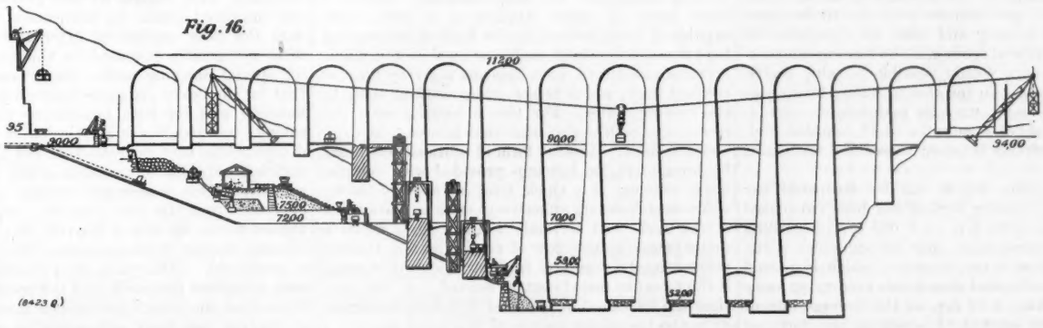


Fig. 16.



neighbouring arch through the intervening buttress, as will be clear from Fig. 6. These pipes are strongly reinforced and their thickness has been calculated without any reference to the supporting mass around them. In order to ensure perfect water-tightness they are lined with welded plate, the space between the pipe and lining being grouted under pressure. The eight pipes are arranged in four pairs. At the upper ends they terminate in pockets built out on the up-stream face of the dam, and having sills at the 73·5 m. level. These intakes are well seen in the drawing Fig. 5, and also in the views, Figs. 9 and 10, Plate LXVI. The pockets are furnished with inclined grids. A stop can also be inserted at this level to cut off the supply should the necessity arise. The supply can further be controlled by a horizontal valve placed as shown in Figs. 5 and 6, and by stop valves at the turbines.

As each of the twin turbines is supplied by an independent pipe, any one can be cut out. An additional advantage also arises from the use of two pipes instead of one larger one of equivalent capacity. The weakening effect of the arrangement adopted on the arches and buttresses is much less than would have been the case with single supply pipes. In the neighbourhood of the pipes additional reinforcement has been introduced in the inclined pockets, and the structure of the buttresses, while the stepped up-stream faces may be noticed in both views. Fig. 7, Plate LXV, shows the waterproof coating being placed on the arch deck surface, while in Fig. 8 may be seen the inclined and horizontal coursing of the buttress masonry, as well as the arch ties and the power station outside wall and roadway at the 63 m. level. The latter are again seen in Fig. 14, Plate LXVIII, showing the finished dam and giving a good idea of the graceful finish given by the arches at the top. Figs. 12 and 13, Plates LXVII and LXVIII, also show the dam nearing completion, while in Fig. 11, Plate LXVII, the down stream side of the structure practically as it now stands completed, is shown.

As will be seen from these views, the architectural effect of the structure is excellent, and this has been achieved without the introduction of any elaborate treatment by mouldings, &c. The bold lines of the design are graceful and have required no embellishment, with the result that the desired effect has been obtained without any increase of cost over that of masonry labour. On the down stream side the pleasing effect is accentuated by the colour relief afforded by constructing the top arches of Busachi granite of a clear grey blue, which is quite distinct from the red coloured trachyte of which the buttresses are built.

ROLL BEARINGS FOR COLD ROLLING MILLS.

By C. E. Davies, A.M.I.Mech.E.

(*Concluded from page* 601.)

Lubrication and Cooling.—The problem of efficient lubrication and of carrying away the heat generated by friction in cold roll bearings is still awaiting complete solution. It is perhaps the most important section of the subject of this article, and in itself involves reconsideration of the previous sections dealing with design and material. From purely mechanical considerations the difficulty of hot bearings and excessive frictional losses can be eliminated, as in the case of other machinery, by simply increasing the bearing surface until the pressure per unit area is kept within the limits required for efficient lubrication. Pressures common in cold mill practice (frequently 2,000 lbs. or even 3,000 lbs. per sq. in.) would not be tolerated in engine or general machinery practice. Unfortunately it is not commercially possible to provide sufficient bearing area to reduce the intensity of pressure to, say, one-fifth of the above-mentioned figures, as would be necessary if the heating of bearings were to be prevented entirely. To increase the length and diameter of the roll neck means also increasing the diameter of barrel, and a very much larger mill would be required than is usually employed for any given duty. Bearing in mind that the proportion of the total power applied to a cold rolling mill, especially those finishing thin metal strips, which is lost by friction in the bearings, is frequently 50 per cent., the difficulty in dissipating the heat generated is obviously great. In a mill with rolls of medium size, such as 10-in. diameter, cold rolling steel or non-ferrous metal strip, the total power absorbed on heavy reductions would be somewhere in the region of 40 h.p., with a roll speed of about 30 r.p.m., say, 75 f.p.m. rolling speed. Fifty per cent. of this total gives 20 h.p., which is lost by friction in the four bearings, that is, about 5 h.p. per bearing. If this is converted into heat units, a total of 210 B.Th.U. per minute is shown to be generated in each bearing and must be dissipated by radiation or artificial cooling, if the bearing temperature is to be kept within possible working limits. Such a load as this, in the case of rolling long strips of metal from coils, may be maintained continuously for periods of 5 minutes to 15 minutes, and, with short intervals between passes, for an 8-hour shift.

The horse-power which can be dissipated per square inch of bearing surface has been calculated to range from 0·085 h.p. to 0·065 h.p., according to various circumstances, chief among which is the amount of oil or other lubricant which is passed through the bearing and thus assists in carrying away the heat. Taking 0·07 h.p. as the average rate of dissipation, the amount of power in the form of heat, which can be dissipated without artificial cooling in the 10-in. mill cited above would be: $45 \cdot 5 \times 0 \cdot 07 = 3 \cdot 2$ h.p. (45·5 sq. in. being the bearing surface of one roll neck in a 10-in. mill of average design.) As the heat is generated at a rate equivalent to 5 h.p. per bearing, 1·8 h.p. remain to be dissipated by artificial means, such as water cooling. In this connection, it must be remembered that, in addition to bearing friction, a certain amount of heat is generated by molecular friction in displacing the metal between the rolls.

Another example of heavy friction losses is the case of rolling tin foil in continuous length. This material is rolled in long coils down to 0·001 in. thick, and even finer, in widths of about 15 in. The power taken on such work by rolls 9 in. in diameter may be as much as 18 b.h.p., and as the actual work of reducing the metal is very small indeed, the proportion of the power lost in friction will be as much as 90 per cent. of the total, or from 3 h.p. to 4 h.p. per bearing. From the above examples, it will be clear that cold roll bearings have to carry heavier loads than is required of bearings in any other class of machinery, and the trouble is that, owing to the great intensity of bearing pressure, proper lubrication, sufficient to maintain a film of oil between the rubbing surfaces, is extremely difficult, with the result that the coefficient of friction reaches a high value, and an excessive amount of power is absorbed in bearing friction. Fortunately, the journal speeds are comparatively low. Taking the average neck diameter as 75 per cent. of the roll diameter, and usual British rolling speeds from 50 f.p.m. to 80 f.p.m., the corresponding journal speed will be from 37 f.p.m. to 60 f.p.m. In American practice, with the much higher rolling speeds of 150 f.p.m. to 200 f.p.m., the journal speeds are 110 f.p.m. to 150 f.p.m. For these higher speeds, which are quite common in the United States, larger rolls for any given duty than would be employed in this country are necessary in order to reduce the intensity of bearing pressures, and also to increase the radiating surfaces. The problem may be divided into two parts, first, the reduction of frictional losses by improving bearing design and providing efficient lubrication, and, secondly, the provision of means of carrying away the heat generated. It is, of course, better to attain success by the first method, as this would tend to prevent the evil of hot bearings, whereas the second is merely a partial cure, and while efficient lubrication reduces frictional losses, cooling devices to a great extent only prevent these losses increasing beyond the limits of practical working. The mill designer has, therefore, to decide under which heading the problem should be attacked, and unfortunately the conditions of efficient lubrication and efficient cooling are to some extent antagonistic.

Generally, British cold rolling mills are very heavily loaded, and the maximum reductions which the mill will stand are obtained, consequently bearing pressures are heavy, proper lubrication in the sense usually understood by engineers is impossible, and the provision of artificial means of carrying away heat generated is essential. Under these conditions, the direct application of water by means of a spray or jet on to the roll neck is the only way of keeping down the temperature of the bearings. This system necessitates the use of open bearings, as shown by Fig. 20, opposite, and prevents the application of any really efficient lubrication. Oil is, of course, useless, as the water would immediately wash it away, and the only lubricant possible is some form of grease, applied in a solid form, capable of being melted by the heat of the bearing. Suet is much favoured, and is as good as any manufactured substitute, as it deposits a greasy film on the roll neck, which is not easily washed away by the cooling water. For this a bearing with side recesses to collect the semi-fluid lubricant is to be recommended. Another form of lubricant favoured, by some users, for bearings provided with external water cooling, is a thick fluid of a tarry nature which is sufficiently adhesive to stick to the surface of the neck, and certainly forms a film, which is undisturbed by the flow of cooling water, thereby preventing the excessive friction which would result if the metal to metal contact existed. At the same time the frictional losses must still be considerable owing to the sticky nature of this lubricant.

As with all bearings which are cooled by the external application of water, the half or more of the circumference is exposed to the atmosphere, and unavoidably free access of dirt and gritty matter is allowed to the bearing surfaces; consequently scored necks are almost inevitable and very high friction losses generally exist. This design of bearing and system of lubrication and cooling are more general in this country than any other, and although the mechanical efficiency is very poor, as mentioned above, a better type of bearing is scarcely possible if bearing pressures are allowed to reach the high values which are usual in average practice. These bearings are scarcely ever seen on the Continent, where enclosed bearings with oil lubrication and internal water cooling are the general practice.

If a satisfactory design for an enclosed bearing were possible for automatic oil lubrication, at the same time allowing direct application of water for cooling, many of the objections to the system would be removed. The writer designed a bearing of this type some time ago, shown by Fig. 21, in which the bearing is entirely enclosed, having a hollow cover on the unloaded side, in which a water space is provided, to which are led a water supply pipe and a drain. The bearing itself has two recesses "B" for oil, and to these the oil supply and oil drain pipes are led; so that the oil and water are separated, thereby preventing the latter washing away the lubricant. Provision is made to prevent the waste of oil as far as possible, and the recesses are provided with oil drain pipes to lead the waste oil to a reservoir in the mill bed from which it may be recovered. A certain admixture of water with the oil is, of course, unavoidable, but the two can be separated very easily.

An alternative to any system of external water cooling, as described above, is obtained by the internal cooling of the roll itself. For this the bearing is fitted with a cover to prevent access of dirt and grit, and automatic oil lubrication provided. The general design is shown in Fig. 22. Water is circulated through the interior of the rolls, and is not allowed to come into contact with the bearing surfaces. Oil is fed on to the top roll bearing and is held by means of a pad of felt fitted into the dust cover, from which the surplus flows through a connecting pipe to a similar pad in the lower bearing cover. The waste oil drains into a reservoir in the bedplate, to which it is led by the slope of the top of the bed, and is prevented from running over on to the foundations by the hollow form of the bedplate casting. This system is generally adopted in France, Belgium, Germany, and to some extent in America, and is certainly to be recommended for mills engaged on precision work, producing highly finished material. Greater accuracy can be obtained owing to the fact that the internal water circulation keeps the rolls themselves at a more uniform working temperature. Further, in all cases where mills of ample dimensions for their duty can be employed, this method is quite satisfactory, and up to certain limits of bearing pressure the frictional losses are less and the efficiency greater than is possible with the alternative externally cooled bearing. For mills employed for such work as tin-foil rolling, where the metal is rolled down to an extremely fine dimension, internal water cooling of the rolls is practically necessary and is adopted in all modern designs for this class of work.

Although this system of water circulation through the interior of the rolls has much in its favour, especially with regard to the greater cleanliness and improved means for lubrication, as compared with the older method of external water cooling, it is not greatly favoured in this country except for special finishing mills. Experience has shown that for the heavy pressures required in the average finishing mill for both non-ferrous and steel-strip rolling, internal water circulation is not able to dissipate the heat generated in roll bearings with sufficient rapidity to maintain a low bearing temperature. This conclusion might, perhaps, be expected from the fact that the cooling agent is applied to the interior of the roll, and consequently at some distance from the surface at which the heat is generated. Also there is a tendency for the heat to radiate outwards, and the cooling water has little or no effect until the temperature of the whole of the roll has risen sufficiently to create a considerable temperature difference between the metal and the water. Consequently, internally cooled rolls will tend to rise in temperature up to a certain point, after which a uniform temperature will be maintained without further increase.

In order to maintain really cool bearings under the heaviest loads the external application of water is certainly the most effective, mainly due to the evaporation of the water from the warm surfaces; but in spite of the efficiency of this method of cooling, the disadvantages already enumerated will, no doubt, lead to the substitution of a better system in time. An improvement in this direction is obtained by providing pockets in the bearing brasses themselves through which water is circulated, as shown by Fig. 23. Water-cooled bearings of this type in conjunction with the internal water-cooling of the rolls themselves are the most efficient type of bearing for high-grade mills, and this system of water circulation will keep down the bearing temperature within reasonable limits, even with heavy bearing pressures. Automatic oil lubrication, as shown in Fig. 22 and described above, is quite satisfactory with such bearings. Fig. 23 shows a plain bronze bearing, but water circulation can, of course, be provided in bearings having strips of anti-friction metal let into a "brass" of phosphor bronze. Bearings of this type have given very successful service in mills for accurate finishing

work. The design is necessarily expensive, but very little wear occurs even under heavy loads and, if properly fitted, the frictional losses are reduced to a minimum. For high-speed cold-rolling mills, operating at speeds of 150 to 200 f.p.m., this design has been adopted, together with a system of forced lubrication, the oil being pumped on to each bearing by means of a mechanically operated force pump. This method ensures an ample supply of lubricant to each bearing, and has many advantages over the lubricating system previously described. The ordinary automatic drop-feed lubrication can be improved by providing a separate supply to both top and bottom bearings, instead of leaving the lower bearings to obtain oil which has first passed through the upper roll bearings.

Fig. 20.

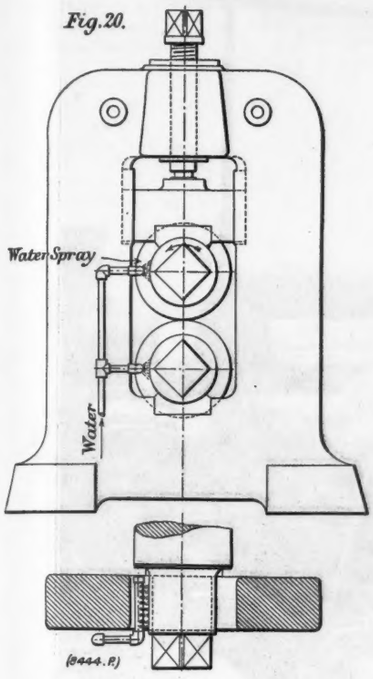


Fig. 22.

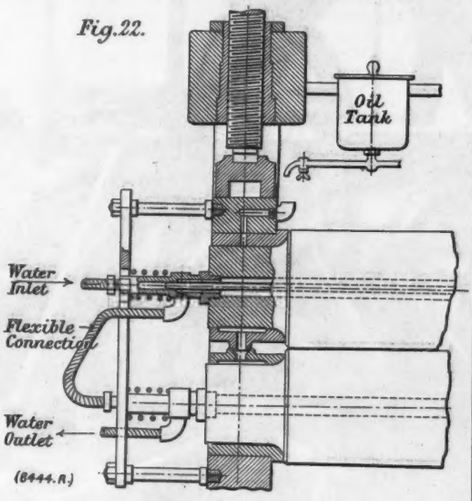
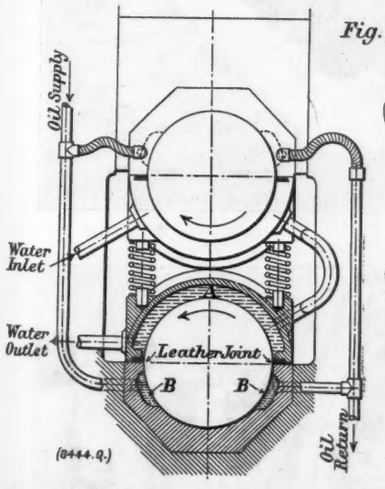


Fig. 21.



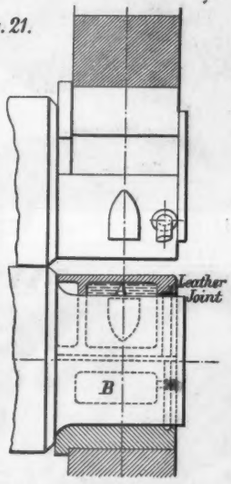
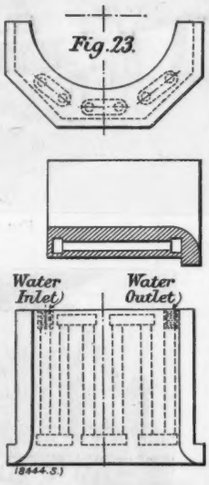


Fig. 23.



Apart from the externally cooled bearing without bearing covers and lubricated by grease, which may still be preferred for simple mills, on rough and heavy work, especially where low first cost is essential, the characteristics of efficient up-to-date roll bearings may be specified as follows :—

(1) The bearings should be of the type with water circulation. (2) The body of the "brass" to be of phosphor bronze with strips of good anti-friction white metal let in, as in Fig. 19, page 601 *ante*. (3) The bearing should be carefully bedded to the roll neck so as to give a uniform and even bearing contact over an arc of about 90 deg., the remainder of the half circumference at the sides being eased away to give ample clearance, recesses being also provided to collect oil, to which suitable oil grooves should be led. (4) Covers should be provided, to exclude dirt and grit. (5) Lubrication should be either of the automatic drip-feed type or, if for high-speed mills, secured by means of forced feed. (6) With this type of bearing the rolls should be provided with internal water circulation, in addition to the water-supply to the interior of the bearings themselves. (7) For efficiency it is essential that the roll necks themselves should be accurately finished by grinding, so as to give a smooth bearing surface truly concentric with the roll barrel.

Great care should be taken to maintain the journal surface in good condition, and any signs of scoring should be removed by regrinding and polishing. The recommendations given above apply only to bearings in the lighter and medium-sized mills for finishing work, where the load is applied continuously for considerable periods of time. In the cases of heavy breaking-down and some sheet mills, where the load is intermittent, the heating of roll bearings does not occur so frequently, nor to such an extent, as with rolls operating on long lengths of thin metal; for such mills solid bronze brasses, preferably lined with white-metal strips and provided with grease or heavy oil lubrication, give sufficiently good results. The external application of water, or some equivalent means of cooling, may be necessary to prevent accidental heating, which might be caused by the presence of grit between the bearing surfaces. With breaking-down mills, where the actual work done in reducing the metal is considerable, the proportion of the power lost in bearing friction is relatively small and efficiency is not of the same importance as it is with mills rolling thin metal.

The possibility of employing roller bearings for rolls might naturally be suggested, and such bearings have been used to some extent in America and also in this country, but the type of bearing fitted was not entirely satisfactory, and very little progress has so far been made in this direction for cold-rolling mills. The Skefko Ball Bearing Company, of Luton, have fitted an improved type of roller bearing to wire-rod rolls with marked success. Although the roll speeds are higher with mills of this class, operating on hot metal, the bearing pressures are much lower than in the case of the cold mill, and the conditions are more favourable to the introduction of roller bearings. It is, however, most probable that progress in the design of roller bearings will make possible the provision of a frictionless bearing of this type which will be capable of withstanding the heavy bearing loads which exist in the cold-rolling mill. This would eliminate entirely the bearing trouble to which reference has been made in this article, and would increase greatly the mechanical efficiency of the mill.

ELECTRIC IRON SMELTING AND THE RESISTANCE OF COKE AND CHARCOAL.

THOUGH not rich in either ores or coal Switzerland has, thanks to the ingenuity and enterprise of its citizens acquired a leading position in several industrial fields. When the dearth of raw materials, especially of iron and coal, became serious during the war, the Federal Government appointed a committee of Swiss experts to inquire into the country's resources of iron and manganese and to report upon their utilisation. Two of the reports by the "Studiengesellschaft für die Nutzbarmachung der schweizerischen Erzlagerstätten" have been published by Messrs. Kümmerley and Frey, of Bern. A third report by R. Durrer, on "Untersuchungen zur Klärung der Frage der elektrischen Verhüttungschweizerischer Eisenerze," dealing with the electric conductivity of coke and charcoal, has been published by the Verlag Stahleisen, Düsseldorf, the research having been conducted by R. Durrer and his collaborators in the metallurgical institute of the Technical High School at Aachen.

Sweden which, together with Italy, may claim to have developed electric iron smelting, commands vast stores both of very pure ores and of charcoal. The iron ores of Switzerland are neither plentiful nor pure, and coke has to be used in the place of charcoal. The question was how the different electric conductivities of the two kinds of carbon would influence the reactions. Charging a rectangular hearth furnace, provided with two electrodes at the ends, with coke ranging from nut size up to lumps of 10 in. Durrer found that the fine coke heated up more slowly than the coarse coke, but finally had a smaller resistance. Durrer points out that the electric current would be conducted both by the solid coke and the arcs between the solid particles; one might further speak of a contact resistance, which, like the arcing, should diminish with increasing consolidation of the heaped-up charge. Finally, the whole charge would cake and the arc effect vanish. It was actually observed that the egg coke showed the maximum resistance, greater than that of nut coke and of the biggest lumps. In the charcoal experiments the charcoal was first overtopped by a bridge of coke to start the current; the resistance of egg coke was about 0·6 of that of charcoal. The coke resistance decreased, rapidly at first, then slower, as the coke was heated to 1,000 deg. C. The charcoal only began to conduct at about 500 deg.; once heated to 1,000 deg., it behaved more like coke.

In the smelting experiments conducted partly in iron works, two Swiss ores, an oolithic brown iron ore which when cold did not conduct at all, and a hematite, were mixed with coke or charcoal in furnaces, provided either with low lateral electrodes or with one and two bottom electrodes, always on single-phase circuits. Of the three materials, ore, carbon, slag, the slag was found to have so much the higher resistance that the thickness and condition of the layer of slag became a factor of importance; consequently the depth to which the electrodes penetrated into the charge had to be well regulated. The phosphorus of the ores passed into the iron, as did also most of the silicon. But the sulphur was almost completely eliminated with the gas, probably as a volatile silicon sulphide; the slag took up very little sulphur. It would further appear possible, according to the report, to smelt iron ores rich in sulphur and in silica in electric shaft furnaces by means of poor coal.

THE ROYAL INSTITUTE OF SCIENTIFIC INDUSTRIAL RESEARCH OF SWEDEN.—This Institute has awarded a gold medal to Dr. Ruths, for his invention of the steam accumulator which equalises intermittent load on boilers.

300-B.H.P. COLD-STARTING HEAVY OIL ENGINE.

CONSTRUCTED BY MESSRS. BLACKSTONE AND CO., LIMITED, ENGINEERS, STAMFORD.

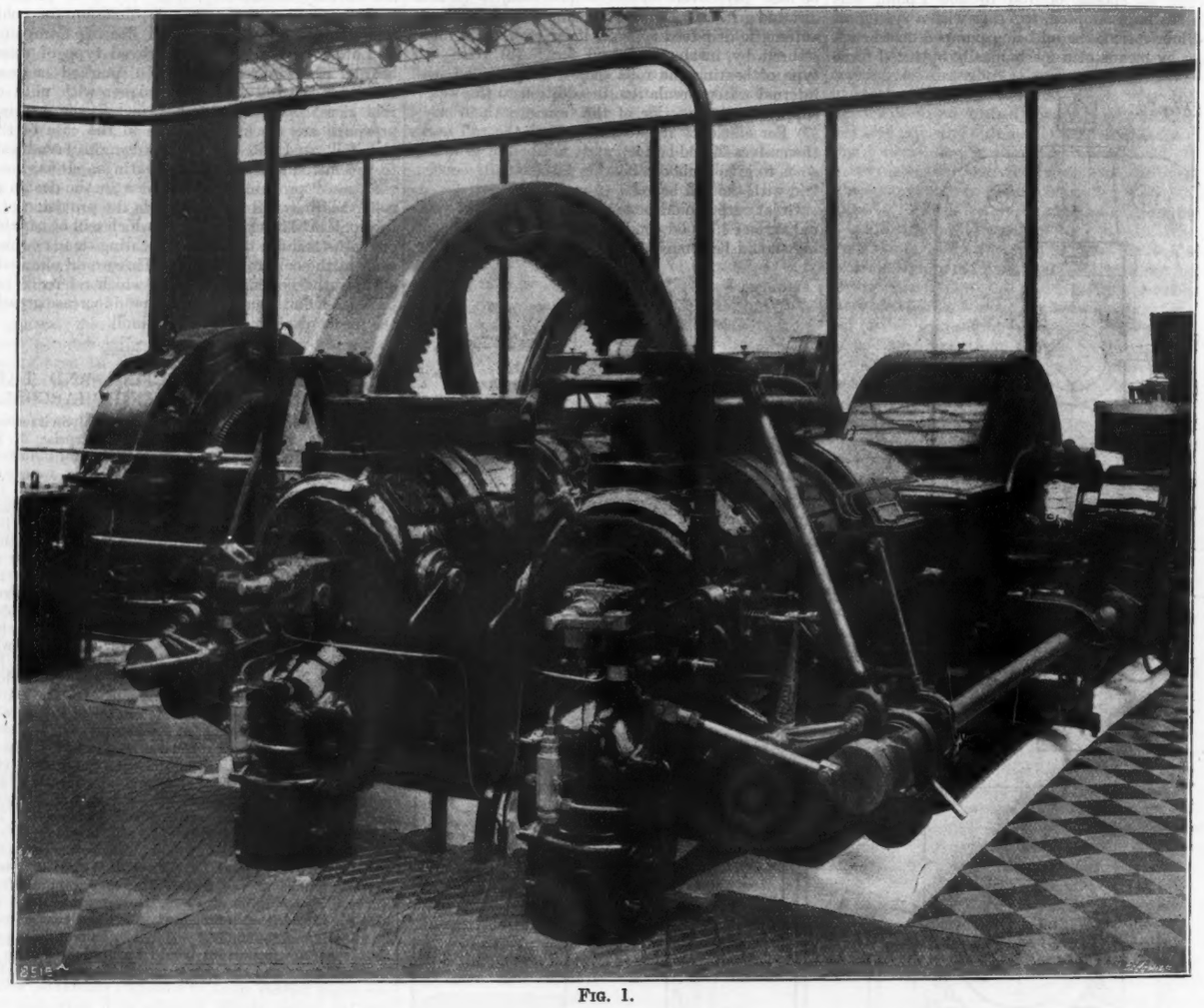


FIG. 1.

300 B.H.P. HEAVY OIL ENGINE.

A PART of the electrical power required for the British Empire Exhibition was generated by plant running on the stands of exhibitors in order that the manufacturers might be able to demonstrate the behaviour of their machines under load. Among the makers who took advantage of this arrangement were Messrs. Blackstone and Co., Limited, of Stamford, who showed the 300 brake horse-power horizontal oil engine, illustrated in Figs. 1 to 7 on this and the opposite pages, as a working exhibit. The general appearance of the engine, which was direct coupled to a 180 kw. direct current dynamo by the English Electric Company, is shown in Fig. 1. It is a twin engine, each cylinder developing 150 b.h.p., and designed to start and work on crude or residual fuel oils without the use of compressed air for injection of the fuel. Hitherto in such engines very high compressions and initial pressures have been the rule, the idea being to vapourise and ignite the fuel instantly on its admission to the combustion chamber. In the Blackstone engine the compression pressure is only 350 lbs. per square inch, and the initial pressure, when the engine is working at full load is not more than 550 lbs. per square inch, the mean effective pressure being 100 lbs. per square inch referred to the indicated horse-power. The system of fuel injection gives a flat-topped indicator card, and the economy is such that the makers are able to guarantee a consumption of 0·4 lbs. of standard fuel oil per brake horse-power developed. Typical indicator cards are reproduced in Figs. 8 and 9.

The particular interest of the engine lies in the fuel injection system. Details of this are given in Figs. 3, 4 and 5, while the mechanism for operating it, as

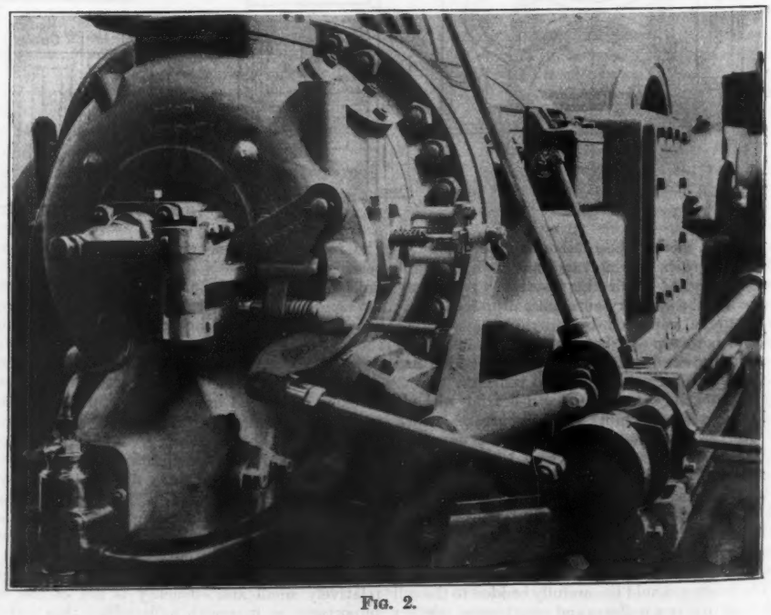


FIG. 2.

DETAILS OF 300-B.H.P. HEAVY OIL ENGINE.

CONSTRUCTED BY MESSRS. BLACKSTONE AND CO., LIMITED, ENGINEERS, STAMFORD.

Fig. 3.

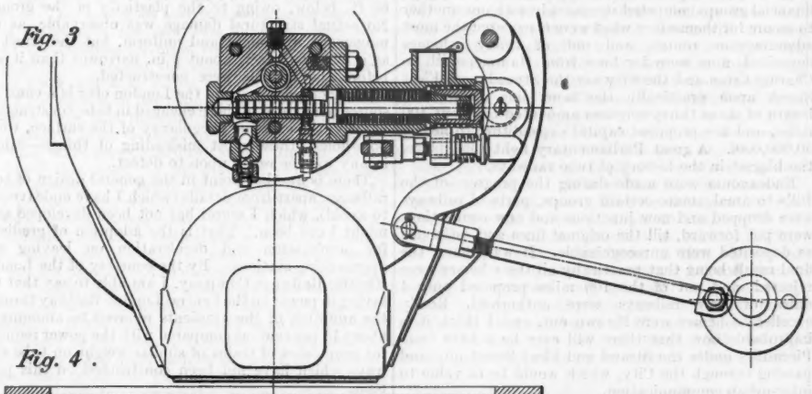


Fig. 4.

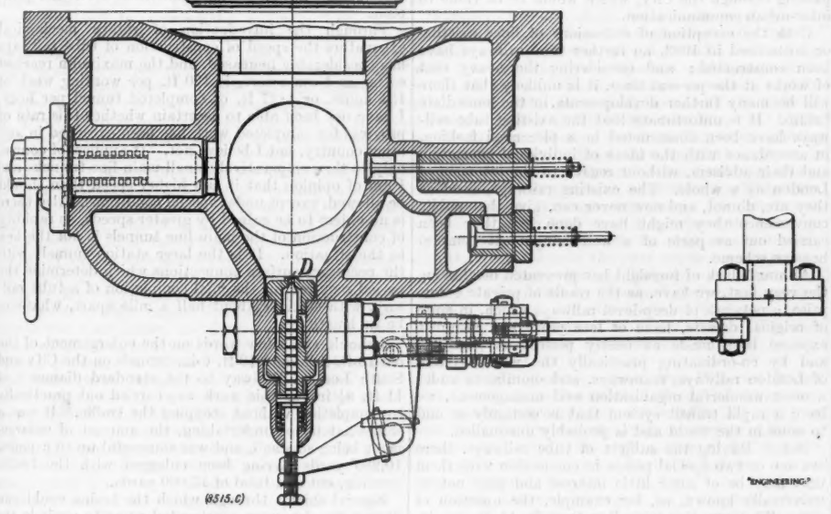


Fig. 5.

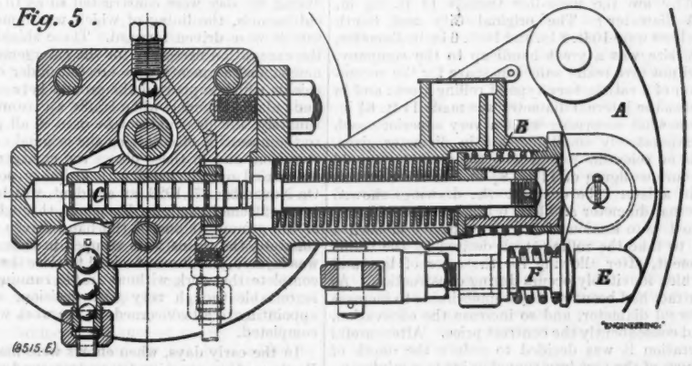


Fig. 6.

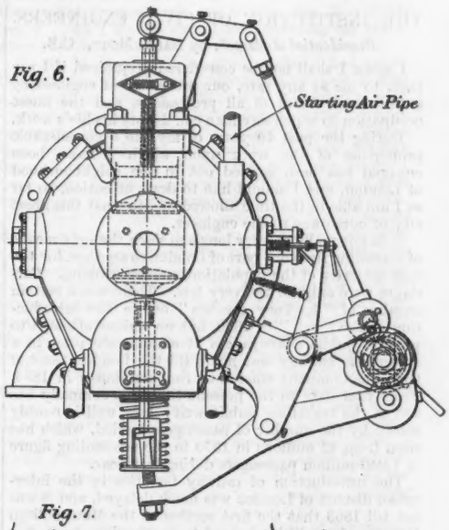


Fig. 7.

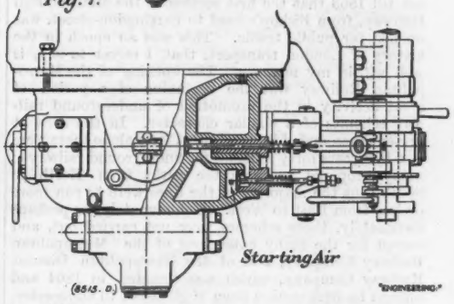


Fig. 8.

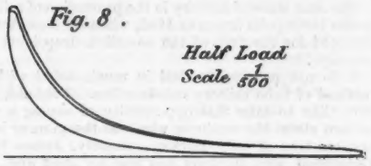
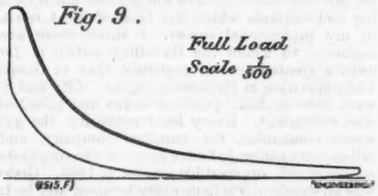


Fig. 9.



well as that controlling the action of the valves, will be understood from Figs. 6 and 7, and from the photographs, Figs. 1 and 2. In the latter it will be seen that the camshaft of the engine terminates in a small disc-crank, which causes the reciprocation of a curved rocking lever at the back end of the cylinder. Reference to Figs. 3 and 4 will show that this disc-crank is provided with angular adjustment for timing. The rocking lever, marked "A" in Fig. 5, carries a hardened steel roller which works in contact with a hardened steel cap B, the inward motion of which compresses a stiff spiral spring and so tends to force the plunger C forward. The motion of the plunger is resisted by oil in front of it which is trapped between the non-return ball inlet valve and the spraying valve D (Fig. 4), so that the plunger cannot move until the spraying valve is opened. On the rocking lever A is an abutment E, which, at the forward end of the travel of the lever, comes in contact with a pin, F. This pin is forced inwards against the pressure of the spiral spring surrounding it, which otherwise holds the spraying valve closed by the system of levers shown. A very slight movement of the pin F is sufficient to open the spraying valve when the fuel is suddenly injected by the action of the spring on the plunger C. On light loads the governor does not permit the fuel pump to force so great a quantity of oil in front of the plunger C, so that the plunger has a shorter travel and the injection does not last so long. The moment of injection is, however, unchanged, as this is determined by the contact of the abutment on the lever A with the pin F. It should also be noticed that the force with which the oil is injected, being dependent only on the action of the plunger spring, will not vary with the speed of the engine, and a proper spray will therefore be obtained from the moment of starting the engine. This is a great advantage at starting, as it enables the engine to be started up from cold with the fuel on which it is to be run, no petroleum ever being needed. Furthermore, the fuel has not to be pre-heated before injection, except it is of such a nature that it cannot be pumped when cold.

The smaller sizes of engine which can be pulled round by hand, can be started on half-compression by means of a removable plug to which is attached a smouldering rag or other device. Half-compression is produced by keeping the air valves open longer than usual, instead of by the more common method of giving the exhaust valve a second motion. Large engines of course are started by compressed air from containers which are charged automatically from the cylinders when the engines are at work. In the case of engines if over 100 brake horse-power, it is considered advisable to fit a small auxiliary engine and compressor in case the pressure in the container should at any time be lost, as otherwise a lot of hand-pumping is required.

The 300 brake horse-power engine at Wembley had a camshaft on either side, and might be regarded as a right-hand and a left-hand engine placed side by side and working on the same shaft. The single governor on the right-hand engine operated on both fuel pumps and ensured that each cylinder should carry the same load. When more than two cylinders are used, the camshaft is carried along the top of the cylinders, instead of across the back as in some designs, and thus allows of each combustion chamber, valve, and fuel injector being removed without disturbing any other cylinder details. The Blackstone spring-injection

engines are made of the single cylinder type in sizes from 8 brake horse-power to 150 brake horse-power, and with two or more cylinders up to 900 brake horse-power.

THE INSTITUTION OF CIVIL ENGINEERS.

*Presidential Address**, by BASIL MOTT, C.B.

I HOPE I shall not be considered prejudiced if I say that, to me at any rate, our profession of engineering is the most useful of all professions, and the finest occupation to which any man can devote his life's work.

During the past 40 years of my life a considerable proportion of the work upon which I have been engaged has been carried out in the neighbourhood of London, and I should like to draw attention, so far as I am able in the time allowed me, to what this great city of ours owes to the engineer.

It is not really so very long ago since the only means of travelling from one part of London to another, for the vast majority of the population, was by walking. Carriages were only for the very few. There was a certain number of "hackney coaches" before the introduction of the "cab" in 1820, but no serious attempt to provide public conveyances at a moderate price in a systematic manner was made till the London General Omnibus Company started to run omnibuses in 1856. From that date to the present time this company has served the travelling public well; how well is readily shown by the number of passengers carried, which has risen from 42 millions in 1870 to the astounding figure of 1,040 million passengers during last year.

The introduction of railway facilities in the inter-urban district of London was much delayed, and it was not till 1863 that the first section of the Metropolitan Railway, from Bishop's-road to Farringdon-street, was opened for public traffic. This was an epoch in the history of London transport, that, I regret to say, is well within my memory. The opening of the Metropolitan Railway was the beginning of a period of great activity in the promotion of underground railway schemes of a similar character. In the area at present surrounded by the Inner Circle alone there were in a few years forty schemes for underground railways; many proposed to cross the parks from North to South, but the majority of the lines were to run more or less from East to West. Unfortunately, or perhaps fortunately, these schemes were not carried out, and except for the many extensions of the Metropolitan Railway Company, and of the Metropolitan District Railway Company, which was founded in 1864 and opened its first section from High-street to Gloucester-road and Westminster, no other railway facilities of moment were given to the people of London till the year 1890.

The next wave of activity in the promotion of railways in the Metropolis began in 1885, when the first Act was obtained for the first of the so-called deep level tube railways.

I do not propose to deal in much detail with the method of tube railway construction. I should, however, like to take this opportunity of saying a word or two about the engineer who was the pioneer in the construction of tube railways, namely, James Henry Greathead, who 40 years ago was my chief and, later on, my very dear friend, to whom I owe much for teaching and example which has been of great use to me in my professional career. I think there are few engineers to whom the travelling public of London owes a greater debt of gratitude than to Greathead. The opposition in Parliament to the "City and Southwark Subway Bill" (which was the first tube railway) was very great. Every local authority, the gas and water companies, the omnibus company, and the railway companies, in fact, every one who could establish a *locus standi*, opposed his scheme in 1884. Greathead was an excellent Parliamentary witness, and he fought the case successfully with great courage and with that constant courtesy to his opponents for which he was so well known.

It is great tribute to Greathead's foresight and ability as an engineer that although about 80 miles of tube railway tunnels have been constructed by other engineers since his death 28 years ago, the methods of construction he originally adopted and the shield used are still in accordance with this original design, except for some modification in detail, and the introduction of mechanical excavation.

New ideas and inventions such as Greathead's stimulated activity, and between 1885 and 1890 no fewer than seventeen new schemes for tube railways were proposed, but none of them received Parliamentary sanction. Immediately, however, the City and South London Railway was opened in December, 1890, the possibilities of this type of railway were proved. There was then another period of activity similar to that which followed the opening of the first section of the Metropolitan Railway in 1863. Parliamentary Committees began to look with more favour on new schemes brought before them, and between 1890 and 1900 thirty-two new tube railways were proposed and seventeen were authorized. Then, however, from 1900 to 1902 came a period of disappointment. Powerful financial groups competed strenuously with one another to secure for themselves what were considered the most advantageous routes, and out of thirty schemes deposited, nine were for lines from Hammersmith to Charing Cross and the City *via* the Strand and Fleet Street upon practically the same line. The total length of these thirty schemes amounted to about 100 miles, and the proposed capital expenditure to nearly 50,000,000*l*. A great Parliamentary fight took place, the biggest in the history of tube railways.

Endeavours were made during the progress of the Bills to amalgamate certain groups, parts of railways were dropped and new junctions and new connections were put forward, till the original lines and estimates as deposited were unrecognizable. It was chaos, the final result being that practically all the schemes were rejected, and out of the 100 miles proposed only 4 miles of new railways were authorized. Really excellent schemes were thrown out, and I think it is improbable now that there will ever be a tube from Piccadilly under the Strand and Fleet Street into and passing through the City, which would be of value to inter-urban communication.

With the exception of extensions of lines existing or authorised in 1903, no further tube railways have been constructed; and considering the heavy cost of works at the present time, it is unlikely that there will be many further developments in the immediate future. It is unfortunate that the existing tube railways have been constructed in a piecemeal fashion, in accordance with the ideas of individual promoters and their advisers, without regard to the interests of London as a whole. The existing railways, good as they are, do not, and now never can, give that public convenience they might have done had they been carried out as parts of a well-thought-out comprehensive scheme.

Although lack of foresight has prevented our having the very best, we have, as the result of private enterprise, a network of deep-level railways which, in spite of original defects, have of late years and at great expense been made as nearly perfect as possible; and by co-ordinating practically the whole system of London railways, tramways, and omnibuses under a most wonderful organisation and management, we have a rapid transit system that is certainly second to none in the world and is probably unequalled.

Before leaving the subject of tube railways, there are one or two special points in connection with them that may be of some little interest and may not be universally known, as, for example, the question of size. Why are the main-line tunnels 11 ft. 8¼ in. internal diameter? The original City and South London lines were 10 ft. 2 in. and 10 ft. 6 in. in diameter, but this size was a great handicap to the company, as it did not give really sufficient space for the accommodation of a satisfactory type of rolling-stock, and in later tubes the internal diameter was made 11 ft. 8¼ in. It is somewhat surprising what a very superior coach this comparatively small increase in diameter gives. There is no scientific reason why the diameter should be the curious figure of 11 ft. 8¼ in. It arose in this way: in a later tube contract the drawings showed the internal diameter as 11 ft. 6 in., but the engineers concerned were anxious as to the capacity of such a tunnel to take the rolling-stock desired by the traffic department, after allowing for the error of line and level which inevitably occurs during construction. As the contract had been let, it was undesirable to increase the *external* diameter, and so increase the excavation, &c., and consequently the contract price. After careful consideration it was decided to reduce the depth of the flanges of the cast-iron tunnel lining to a minimum. This reduction of the flanges increased the internal diameter to 11 ft. 8¼ in., the outside diameter remaining the same. All other tubes have been constructed to this dimension as a standard gauge.

The station, crossover and junction tunnels, &c., are of varying sizes up to 30 ft. internal diameter, and for short lengths the diameter has reached 35 ft. These figures show how readily the London clay, in which the great bulk of tube railways have been made, lends itself to the construction of tunnels of all sizes, and the existence of tube railways is largely owing to the presence and properties of the London clay. This is usually hard and very tough, and I think if it could be immediately protected in tube railways from the action of the air, great lengths of tunnel would require no lining at all. Under some parts of London, particularly the City, the clay has a peculiar characteristic which is not so apparent further south or west. If you drive a bar into the clay in this area and withdraw it, leaving a circular hole, you will find that in the course of about an hour the hole will be completely closed.

This plasticity was particularly noticeable during the construction of a tube through the City, where a very slight hair crack in the surface of the street was observed about 50 ft. in advance of the tunnel face, and it extended hour by hour as the work progressed 60 ft. below, owing to the plasticity of the ground. No actual structural damage was observable, as the movement was slight and uniform, but the street is, as a matter of fact, about ½ in. narrower than it was before the tunnels were constructed.

Another peculiarity of the London clay is a constant source of anxiety to those engaged in tube construction, namely, the extreme irregularity of the surface, which bore-holes—those most misleading of things—cannot in any way be relied upon to detect.

There is another point in the general design of tube railways, apart from details (which I have endeavoured to avoid), which I regret has not been developed as it might have been. That is the adoption of gradients for acceleration and deceleration on leaving and approaching stations. By the courtesy of the London Electric Railways Company, I am able to say that the saving in power on the Central London Railway through the adoption of the gradients referred to amounts to about 15 per cent. as compared with the power required for propulsion of trains of similar weight on tube railways which have not been constructed on this principle.

Through the introduction of rotary mechanical excavators the speed of construction of tube railways has considerably increased, and the maximum reached so far as I am aware, is 170 ft. per working week of 134 hours, or 1·27 ft. of completed tunnel per hour. I have not been able to ascertain whether this rate of progress for completed work has been exceeded in any other country, but I believe not. It applies, of course, only to the comparatively small main-line tunnels, and I am of opinion that it is a higher speed than should be allowed, except under special conditions. Also there is no object to be gained by greater speeds, as rapidity of construction of the main-line tunnels is not the key to the situation. It is the large station tunnels with the necessary surface connections which determine the period required for the final completion of a tube railway, with stations about half a mile apart, whatever be its length.

I should say a few words on the enlargement of the old 10-ft. 2-in. and 10-ft. 6-in. tunnels on the City and South London Railway to the standard diameter of 11 ft. 8¼ in., as this work was carried out practically to completion without stopping the traffic. It was a somewhat novel undertaking, the amount of enlargement being so small, and was successful up to a point, 10,280 yards having been enlarged with the traffic running, out of a total of 13,000 yards.

Special shields through which the trains could run during the day were constructed so as to encircle the old tunnels, the lining of which was removed as the shields were driven forward. These shields cut away the excavation necessary for the enlargement, and the new tunnel segments were erected under cover of the shields which supported the ground between the small and enlarged tunnels when traffic was running. Unfortunately, shields could not be used in all places owing to the necessity of adjusting the original errors of construction, and in these places the enlargement had to be carried out by hand with ordinary poling boards. On November 27, 1923, an accident, which might have been extremely serious, happened through subsidence of the ground at one of the hand-driven faces. Fortunately, the trains were stopped in time, and no one was injured, but it was decided to close the railway and complete the work without traffic running. It was a regrettable though very wise decision, and one disappointing to all concerned, as the work was so nearly completed.

In the early days, when efforts were made to obtain Parliamentary sanction for underground railways, one of the chief arguments used in their favour was that such railways would remove traffic from the streets and so decrease the congestion, which even 30 years ago was causing anxiety, and the chief argument put forward by the omnibus and tramway companies and others against the schemes was that they would be robbed of traffic which, in their opinion, was only just sufficient to keep them alive, and that they would consequently die. What are the facts? Going back for the moment to the traffic carried in 1870 by the means (other than cabs and private carriages) then available for transport, which consisted of the London General Omnibus Company, the Metropolitan Railway, and a few miles of the Metropolitan District Railway, the total number of passengers amounted to 90 millions. Tramways were started in 1870, and traffic began to increase rapidly with the creation of new omnibus companies and railway extension, and in 1880, after a period of 10 years, the number of passengers carried had risen to 220 millions. In 1890 the total was 460 millions. In 1900 it reached a total of over 800 millions, and in 1923 the total passengers carried by all methods of

* Delivered on Tuesday, November 4, 1924, abridged.

public transport reached the astonishing figure of about 2,600 millions in the metropolitan area, and this is exclusive of the suburban passengers brought into London by the main-line railways, except in so far as they may travel afterwards by the metropolitan services. This enormous and increasing movement of people emphasizes the fact that in large cities the greater the facilities for rapid transport at reasonably cheap rates, the greater the volume of traffic. Some radical steps will have to be taken in the next few years if locomotion in our main thoroughfares is not to become a farce, and the most rapid way of travelling above ground to be by walking, as in the very early days when there were no facilities at all. Indeed, in the City itself that time, for all practical purposes, has already arrived. No doubt much could be done by traffic diversion and regulation. Something, however, of much greater scope than traffic regulation will undoubtedly have to be undertaken in the near future. If new streets are the only solution, I sincerely trust they will not be overhead to disfigure for ever our great City. If there must be new streets let them be underground, and such a proposition is, I think, by no means impossible. If the Traffic Authority were granted the same powers as are already possessed by the London County Council and other authorities, and if compulsory powers were given for passing under property at a reasonable depth for a reasonable wayleave, then such streets would be practicable and of real value. The cost would, of course, amount to many millions, but would probably be less than that of any other scheme for relief on a large scale. I think that the suggestion recently brought forward with some prominence by Sir Alfred Yarrow to obviate the blocking of traffic at the intersection of main streets, by the construction of inclined crossings, is worthy of very serious consideration. I do not think that Sir Alfred claims that the idea is altogether new, but it certainly has this wonderful novelty about it, that he has, with his usual generosity, offered to find the money for a trial of the proposal in so far as the actual works are concerned. I am not sure that an offer of this kind, purely in the public interest, has ever been made before.

The traffic regulation is most difficult, not where roads meet at right angles, but where they meet at more or less acute angles, and I have made, as a matter of interest, an approximate estimate of the cost of inclined crossings at Hyde Park Corner. Here you have traffic from Hyde Park to Constitution Hill and Victoria crossing in various directions the main stream of traffic from Piccadilly to Knightsbridge, and also to Victoria and *vice versa*. This could be avoided by adopting Sir Alfred Yarrow's suggestion. The cost would be approximately 150,000*l.*; and if made below ground there would be no superstructure to injure the æsthetic beauty of this magnificent site, where congestion is severe. Further east, at the junction of Waterloo Bridge with the Strand, at Ludgate Circus, and at the junction of Blackfriars Bridge with Queen Victoria-street and the Embankment, inclined crossings could be constructed, and there are many other points which could be treated in the same manner. Unfortunately, at Oxford Circus and Piccadilly Circus and in the City, the conditions are such that their construction either above or below the surface would present very great difficulties.

Turning to cross-river communications between Middlesex and Surrey in the London area, the development has hardly kept pace during the last 50 years with the growing needs of the population.

From Vauxhall Bridge to the Tower Bridge, both inclusive, we have only added 85 ft. of width of roadway by bridges across the river during 50 years. It is perhaps even more surprising that, taking the central area of London—that is, from Westminster Bridge to the Tower Bridge, a distance of nearly 2½ miles—only 55 ft. of width of roadway has been added to our cross-river communications since 1831, or in nearly 100 years. The only additions have been the widening of Blackfriars Bridge by 48 ft. in two stages, and the reconstruction of Southwark Bridge, 7 ft. wider than the old bridge designed by Rennie and completed in 1819. Even this is somewhat misleading because, of the 30 ft. second widening of Blackfriars Bridge, 17 ft. at the side of the roadway is monopolised by tramways. Anyone observing the tramways on Blackfriars and Westminster Bridges, where the same conditions exist, will notice that the area occupied by tramways is for all practical purposes useless for ordinary vehicular traffic. So it really amounts to this, that the width of roadway communication across the river between Westminster and the Tower Bridge for vehicles other than tramways has been increased by only 38 ft. in the last 100 years, which hardly seems adequate to meet modern requirements. In matters of public interest we appear to have greater difficulty now in making up our minds what to do, and in doing it, than our predecessors had. In the early part of the nineteenth century they do not appear to have had these difficulties, because four bridges were decided upon and were built, namely, Waterloo, Southwark and London Bridge designed by Rennie, and the old Vauxhall Bridge designed by Walker. In the bridges designed by Rennie, as was customary at the time, the piers and abutments were founded on timber piles driven into the bed of the river. Two layers of heavy cross timbers were laid on the tops of the piles and planked over with another timber platform about 6 in. thick, upon which the actual masonry was built. A somewhat interesting point in connection with the timber foundations of these bridges over the Thames is the length of time they last, which is apparently about 100 years. In the case of the Southwark Bridge, which was commenced in 1814, some settlement of the piers showed itself in 1890, and increased gradually till the reconstruction of the bridge in 1913. In reconstruction the number of arches was altered from three to five, and it was necessary for navigation purposes to remove the old piers and their timber foundations entirely. They were removed inside cofferdams, so that the actual condition of the timber was shown beyond doubt. The piles themselves were generally well preserved, but the horizontal timber platforms had deteriorated so seriously that the heads of the piles pierced into them. The masonry had, of course, followed the sinking platform, causing settlement after a period of 100 years.

Waterloo Bridge, which was constructed in the same manner as Southwark Bridge so far as the foundations are concerned, was opened in 1817, and has for many years shown signs of gradual settlement. As is now well known, this movement increased rapidly about June, 1923, particularly in one of the piers of the centre arch, and the bridge was closed for traffic by the London County Council in May, 1924, during temporary repairs. From close inspection there is no doubt that this settlement is due to the deterioration of the timber platform, as at Southwark, and the period is also a little over 100 years. London Bridge was completed in 1831, and if it follows the example of Waterloo and Southwark we may expect trouble with the foundations in the next ten or twenty years.

Old Westminster Bridge, designed and constructed on a pile foundation by Charles Labelye, was opened for traffic in 1749, and about 100 years later, in 1856, the centre arch subsided, as in the case of Waterloo Bridge. It was then removed and replaced by the present structure.

I think it is generally agreed that Waterloo Bridge is one of the most beautiful of Rennie's bridges, but from an engineering point of view the old cast-iron Southwark Bridge was the most interesting, not only because the centre arch, with a span of 240 ft., was the largest cast-iron arch ever built, but also for its unique design.

I should like to refer again for a moment to the question of elasticity of the London clay whilst touching on the work of the engineer in regard to cross-river communication, because the movement can be more readily perceived on the piers of bridges than elsewhere. This has lately been rather strikingly illustrated during observations taken at Waterloo Bridge on the piers of the central arch. It was found that these piers rise and fall with the tide—that is to say they sink as the tide rises and rise as the tide falls, owing to the weight of water compressing the elastic foundation. The movement is about $\frac{1}{8}$ in. to $\frac{1}{16}$ in.

I think that this movement really extends for some distance north and south of the river itself, probably for several hundred yards to a degree which is quite perceptible with precision instruments. Observations which are being made at St. Paul's Cathedral show certain vertical movements of the structure as a whole, but these observations have not yet been carried over a sufficiently long period to enable me to give the amplitude of the movement which certainly occurs and is probably tidal.

One of the great assets and delights of our profession is that our life work, however hard it may be, and however full of disappointments and trials and failures, is work of exceptional interest; and it is open to every member of the profession to leave behind him something, however small, which is useful to his fellow-men and to his country when his efforts are over.

LETTERS TO THE EDITOR.

"MISSING PRESSURE AND HEAT LOSSES IN GAS ENGINES."

To the Editor of Engineering.

Sir,—In my oral reply at the Institution of Mechanical Engineers on October 24, which is reported in the current issue of your journal, I stated that the temperature at the peak of the Hopkinson indicator diagram was 1,980 deg. This temperature I ought to have stated was measured on the absolute scale. On the centigrade scale it is 1,700 deg. The substitution of 1,700 deg. for 1,980 deg. does not, of course, affect my thesis, but lends it even greater support. The dissociation tables calculated from the experiments of Pier and Bjerrum (upon which Messrs. Tizard and Pye have based their work in connection with the petrol engine) show that at this temperature the amount of dissociation is only a fraction of 1 per cent. Gas engine temperatures are usually less than 1,700 deg. C., and I see no reason for correcting my statement that dissociation in gas engines is very small.

Mr. H. M. Martin, while agreeing that I had established a case for delayed combustion, suggested that a dissociation due to radiation in accordance with views put forward by Professor Perrin, might be more important than I thought. I agree with Mr. Martin that Professor Perrin has put forward an entirely rational theory, and during the past two years I have been conducting experiments having a direct bearing on it. These experiments are not yet completed but they have gone sufficiently far to enable me to say that such radiation density as normally occurs within gas engine cylinders is not sufficient to cause dissociation of the rather securely linked CO_2 and steam molecules. My experiments do not, of course, disprove Perrin's theory; indeed, I am inclined to think that with radiation densities much greater than those occurring in gas engine cylinders a substantial dissociation of CO_2 and steam may be effected.

Professor Bone put forward the theory that the gaseous mixture at the moment of maximum pressure might not be in the condition of equilibrium as a result of abnormal distribution of its energy between vibrational, rotational and translational energies. This is a view I held many years ago, but for reasons I put forward in your journal, August 22, 1919, I came to the conclusion that it cannot account for the "missing pressure" to any very appreciable extent.

Professor Bone also criticised my use of a complex mixture of gases like coal gas, and suggested that I should have used pure single gases. I may say that, for certain of my experiments, I used hydrogen, and Professor Bone is aware of these experiments, for he has done me the honour to refer to them in one or two of his Royal Society papers. But I think in this case I was right in using a complex gas because what I wished to find was not whether there is incomplete combustion in the case of pure gases but whether there is incomplete combustion in a gas engine using complex gases.

Yours faithfully,

W. T. David.

Engineering Department, The University, Leeds.
November 3, 1924.

"THE CALCULATION OF QUENCHING STRESSES."

To the Editor of Engineering.

Sir,—I wish to admit a mistake which has crept into Tables I and II of the report on "Quenching Stresses" read before the British Association meeting at Toronto and printed in Engineering, page 343, in the issue of September 5, 1924. While it will not affect the general results, I wish to point it out before anyone may use these tables. I shall be most happy to answer any question that may arise on this paper. The corrected tables are as follows:—

Table I.—*Effect of Drawing (Tempering) on the Maximum Initial Stress for a 0·50 per cent. Carbon Steel heated to 1,500 deg. F., Quenched and Drawn with no Applications of Repeated Stress.*

Draw Deg. F.	Strain Relief. in. per in.	Stress Relief in Centre Fiber. lb. per sq. in.	Per cent. Reduction of Diameter.	Maximum Value of Initial Stress. lb. per sq. in.
0	0·001157	34,300	68·5	38,400
300	0·001107	33,100	69·1	36,700
600	0·000760	21,900	68·5	24,400
900	0·000227	6,800	68·5	7,600
1,200	0·000100	3,050	68·5	3,410

Table II.—*The effect of Reversal of Stress on the Maximum Initial Stress for a 0·50 Carbon Steel heated to 1,500 deg. F. and drawn.*

Draw Deg. F.	Strain Relief. in. per in.	Stress Relief in Centre Fiber. lb. per sq. in.	Per cent. Reduction of Diameter.	Maximum Value of Initial Stress. lb. per sq. in.
0	−0·000064	−1,930	39·1	−3,061
400	−0·000099	−2,970	40·6	−4,610
600	−0·000055	−1,650	39·3	−2,620
800	+0·000086	+2,570	41·0	+3,960
1,000	+0·000045	+1,350	38·5	+2,180
1,200	+0·000013	+ 385	39·3	+ 610
1,425	+0·000008	+ 240	38·8	+ 380

Yours very truly,

T. McLean Jasper.

Engineer of Tests, Fatigue of Metals Investigation, University of Illinois, Urbana,
October 21, 1924.

EXTENSIONS TO ST. PANCRAS POWER STATION.

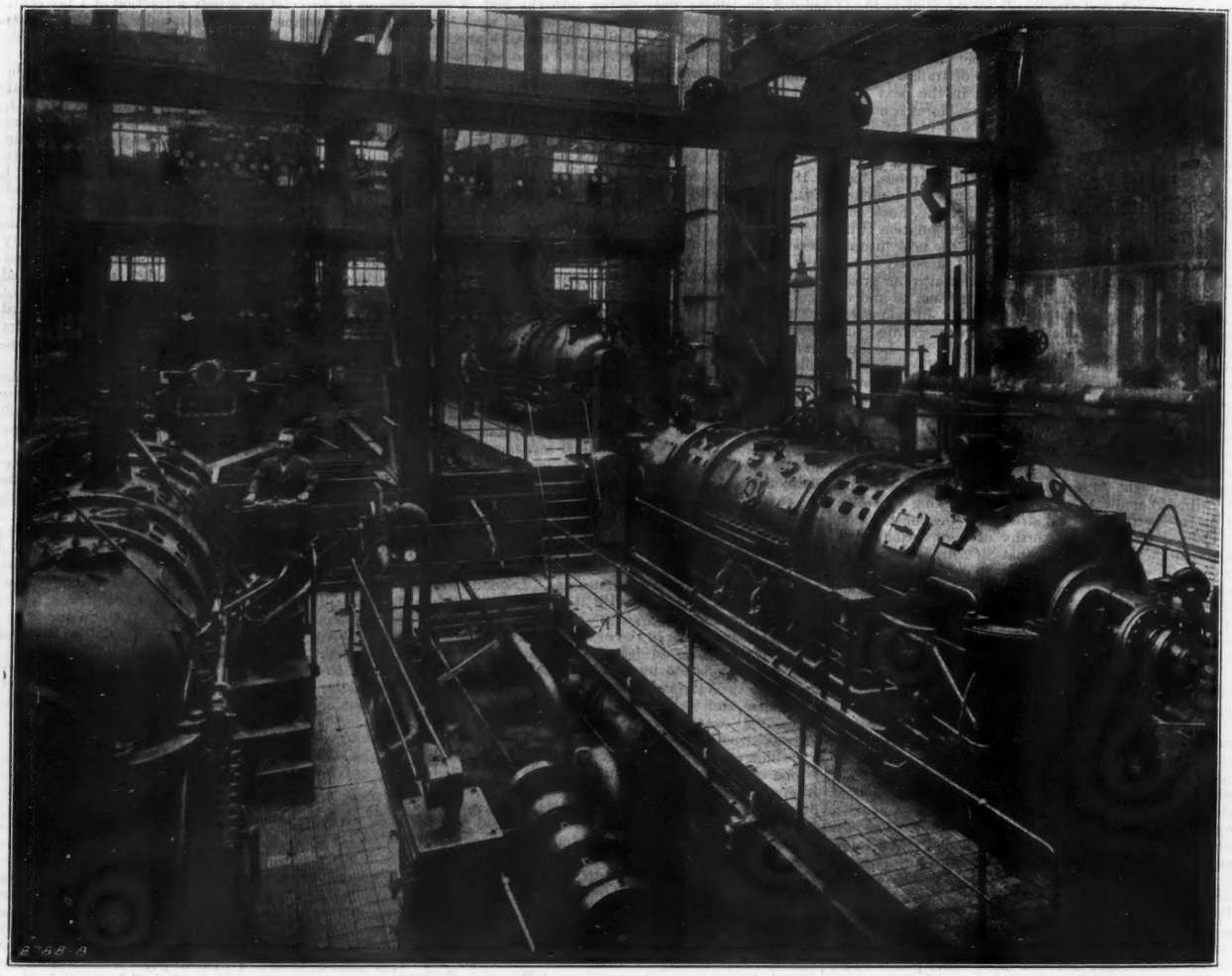


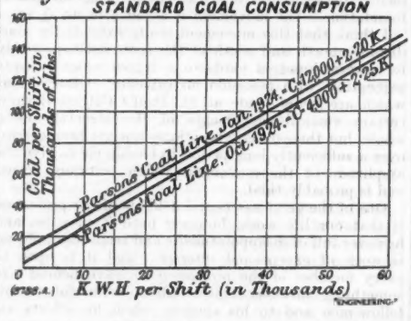
FIG. 1. GENERAL VIEW OF ENGINE-ROOM.

EXTENSIONS TO ST. PANCRAS POWER STATION.

To the old Vestry of St. Pancras belongs the credit of being the first public authority in London to undertake the supply of electricity. It obtained Parliamentary powers for this purpose in 1883, though it was not until 1890 that a start was made by the erection of a small power station at Regent's Park, and in November, 1891, a public electricity supply was available at 220 and 110 volts. In 1894 it became necessary to erect a further generating station which formed the nucleus of the present King's-road plant. This started with an aggregate generating capacity of 390 kilowatts, and the original intention was to supply current on the five-wire system introduced by Dr. Hopkinson in Manchester. Mr. Sidney Baynes, who was then, as now, the chief electrical engineer of the undertaking, decided, however, to keep to the three-wire system and to raise the pressure to 440 volts across the outers, St. Pancras being the first supply undertaking in the country to adopt this pressure. The saving in copper was, of course, enormous, and this, together with the practical advantages of being able to supply power and lighting current from the same distributing mains resulted in the example of St. Pancras being followed generally for low-pressure distribution systems throughout the country. An equally far-sighted policy was adopted with regard to the development of a factory load, and so long ago as 1898 electrical energy for power purposes was sold in St. Pancras for what was then the very low rate of 2*d.* per kw.-h.

By the year 1903, when the annual output of electricity had risen to over 5,000,000 kw.-h., it became evident that the limits of direct-current generation had been reached, and it was decided to put down alternating current machinery transmitting three-phase current

Fig. 2. ST PANCRAS POWER STATION STANDARD COAL CONSUMPTION



at 50 cycles and 5,000 volts pressure to substations for conversion. St. Pancras again led the way among Local Authorities in introducing this system. The first two alternators were driven by Browett-Lindley high-speed engines, but turbines were adopted in 1905, two Parsons machines, each of 1,000 kw. rated capacity, being put down in 1905 and 1906 respectively. The continued growth of the load necessitated further plant in the course of a few years, and in 1912 the St. Pancras authorities ordered from the Brush Electrical Engineering Company, Limited, the first Ljungström turbine to be built in this country. This machine, which was rated at 1,500 kw., was only about the second or third in existence at the time, but its performance completely justified Mr. Baynes' recommendations, and the same type has been adopted in subsequent extensions.

The Brush-Ljungström plant now installed in the King's-road station now consists of the 1,500-kw. set just mentioned, a 3,000-kw. set installed in 1918, a 7,000-kw. set installed in 1923, a 7,000-kw. set officially started up on Friday last, and another set of the same size in the course of erection, an aggregate of 25,500 kw. of this type of plant. A general view of the engine-room, showing the four larger units, is given in Fig. 1. The turbines all work with steam at a pressure of 190 lb. per square inch at the stop valve, and a temperature of 584 deg. Fahr., and exhaust into a vacuum of 28·5 in. The 7,000-kw. machine which has just been put into service, has a condenser of 12,000 sq. ft. of cooling surface and will maintain a vacuum of 28·5 in., when supplied with 8,600 gallons of water per hour at a temperature not exceeding 70 deg. Fahr. The air is extracted from the condenser by a Hick Brequet steam ejector, and the condensate by a water-extraction pump. The ejector will deal with 41 lb. of air per hour. The condensate pump is driven by a 8·5-h.p. Brush direct-current motor, and delivers the condensate against a total external head of 36 ft. into a close-feed system. The steam from the second nozzle of the air ejector is led to a feed-water heater, so that most of the heat of the steam is returned to the system. The cooling air for the two alternators, which make up the unit, is drawn through a Sirocco air washer capable of dealing with 20,000 cub. ft. of air per minute.

The present boiler house contains four boilers, each having a normal rated capacity of 40,000 lb. of steam per hour, and working at a pressure of 200 lb. per square inch. Two of these are of the Niclausse type with Riley stokers, and two of the Babcock and Wilcox type with travelling grates. Each boiler has its own Avery automatic coal scale weighing the coal as it descends to the stoker hoppers. The quantity of coal burnt during every shift is thus known at the end of

GOVERNOR FOR TWO-SPEED OIL ENGINE.

CONSTRUCTED BY MESSRS. VICKERS-PETTERS, LIMITED, IPSWICH.

the shift, and is checked against the electrical output during the same period. There is thus a continual test of the efficiency of the whole plant, which is essential to the maintenance of a consistently high standard of operation. The inauguration of this test, and the greater attention paid to the boiler-house operation generally, has had much to do with the remarkable reduction in coal consumption which has been brought about during the last few years. In the year 1922 the average coal consumption was brought down to about 3·5 lb. per kilowatt-hour generated; last year the average figure was about 3 lb., and this year it will be no more than about 2·5 lb. The rate at which improvement is proceeding is illustrated by Fig. 2, which shows the Patsons lines for January and October of this year. It will be seen from the equations given on the diagram that to generate 35,000 kw.-h. per shift, which represents a typical day-shift output at the present time, now requires a standard coal consumption of 82,750 lb., or 2·33 lb. per kilowatt-hour. Even so recently as January last the standard coal consumption for a shift with the same output was 89,000 lb., or 2·54 lb. per kilowatt-hour. The constant or "no-load" coal consumption of 4,000 lb. per shift, is unusually low for a station with the output of St. Pancras, and that such a figure can be reached is creditable both to the management and to the equipment.

It may be mentioned that an extension of the boiler-house plant now on order will include four more boilers, each of a normal evaporation of 40,000 lb. per hour, working at a pressure of 230 lb. per square inch. Two of these are being manufactured by Messrs. Babcock and Wilcox, Limited, and two by the Vickers-Spearing Boiler Company, Limited. All four boilers will be fired with pulverised coal on the Lopulco system, the contract for the pulverised fuel equipment having been awarded to the Underfeed Stoker Company, Limited, for the first pair of boilers, and Messrs. Vickers and International Combustion Engineering, Limited, acting as sub-contractors for the second two boilers, which will be installed.

TWO-SPEED OIL ENGINE FOR GRAIN ELEVATOR.

An oil engine recently constructed by Messrs. Vickers-Petters, Limited, of Ipswich, for the operation of a grain elevator at the Port of Bristol, is of special interest in view of the conditions, somewhat arduous for an internal combustion engine, which it had to fulfil. The duty of the engine is to drive a two-cylinder reciprocating grain exhauster, and it has to have a speed control by the governor when running 40 per cent. below its normal speed. It has also to maintain at this lower speed the same torque as is exerted at normal speed. The normal speed is 195 r.p.m., and the engine has to develop 250 brake horse-power at this speed, and 150 brake horse-power at the lower speed of 117 r.p.m. To fulfil these conditions a standard four-cylinder engine, rated to develop 320 to 340 brake horse-power at 250 r.p.m., was taken and modified principally in connection with the method of fuel injection. In place of the standard shaft governor with its eccentrically operated pumps, a special fuel pump-box containing four cam-operated fuel pumps has been fitted to an extension of the bed. The cams give the pump plungers a constant stroke of 0·25 in. each by means of an arrangement of rollers and levers.

Governing is effected by means of a centrifugal governor driven by gearing from the fuel pump cam-shaft, as shown in the figure above. This governor operates two disc-type helical cams, each disc carrying two cams. These cams vary the amount of the fuel delivered by passing a greater or less proportion of it. The governor itself is arranged with a hand speeder gear by means of which the speed of the engine can be varied from about 220 r.p.m. to about 110 r.p.m. Adjustment over so long a range of speed is said to be entirely successful. The other alteration from the standard engine was in connection with the fuel injectors, the usual pattern of injectors being replaced by a type which would ensure an injection pressure of 1,000 lbs. per square inch irrespective of the speed of the engine.

A second engine was supplied for the same plant by Messrs. Vickers-Petters, Limited, this being a standard engine developing 71 to 76 brake horse-power at 260 r.p.m. and direct coupled to a dynamo for lighting purposes and for operating auxiliary motors on the elevator pontoon. Tests on the smaller engine showed the fuel consumption to be 0·488 pints per brake horse-power-hour. The main engine consumed 0·466 pints of fuel per brake horse-power hour at 250 brake horse-power, and 0·52 pints per brake horse-power hour when developing 135 brake horse-power at 122 r.p.m. These figures are considered exceedingly satisfactory in view of the fact that the larger engine is really a 320 brake horse-power engine. It may be added that during the shop trials the main engine was run for some hours on boiler oil, on which fuel the consumption worked out at 0·473 pints per brake horse-power hour, or very little higher than with Shell-Mex fuel on which the official trials were made.

TRIALS OF THE ORIENT LINER "ORAMA."

The twin-screw Orient liner Orama, an illustrated description of which appeared in our last two issues, was delivered at Tilbury on Saturday, October 25, by the builders, Messrs. Vickers Limited, after an exhaustive series of trials extending over ten days, which were carried out in the Irish Sea and on the Clyde.

With the exception of the main feed and circulating pumps the whole of the auxiliaries of the ship are electrically driven, and some remarkable results in fuel economy constituting, it is believed, a world's record, have been obtained. The principal trials carried out were:—(1) Progressive trials on the measured mile at Skelmorlie at various speeds from 14 to 20 knots. (2) A full power trial consisting of four runs between the Cloch and Cumbrae Lights, and a further six hours at the same power at sea. (3) A 24 hours' fuel consumption trial at a speed of 14 knots. (4) A 24 hours' fuel consumption trial at a speed of 18·8 knots.

The contract provided for the fuel consumptions at various powers being guaranteed by the builders, and the consumptions during the two trials of 24 hours' duration were of special importance. The results obtained were very gratifying, the consumption during the low power trial being at the rate of 0·924 lb. per shaft horse-power per hour, and during the high power trial 0·785 lb. per shaft horse-power per hour. These figures, including as they do fuel consumption for all purposes, are remarkably low, and are undoubtedly due to some extent to the extensive adoption of electrical auxiliaries and to superheat in the main turbines and the turbo-driven electric generators.

TRIALS OF THE MOTOR-SHIP "SILURIAN."

On Thursday of last week, October 30, the motor-ship Silurian, an 11,000-ton vessel, built by The Blythswood Shipbuilding Co., Limited, of Scotstoun, Glasgow, to the order of Messrs. Owen and Watkin Williams, ran her official trials on the Clyde. The Silurian is 430 ft. long by 57 ft. beam and 33 ft. 2 in. moulded depth, with a designed speed of 10·5 knots. The vessel is fitted with two six-cylinder Beardmore Tosi oil engines, having cylinders 620 mm. (24½ in.) bore by 975 mm. (38⅜ in.) stroke. The trials lasted for six hours, and the vessel maintained an average speed of 11·3 knots, the pair of engines developing an average of 3,300 indicated horse-power at 126 revolutions per minute. The fuel oil consumed during the trials was 6,250 lb., or 0·315 lb. per indicated horse-power for all purposes. This corresponds to 11·15 tons of fuel per 24 hour day. The average pressures recorded were as follows:—blast pressure, 950 lb. per sq. in.; lubricating oil, 11 lb. per sq. in.; cooling water to jackets, 18 lb. per sq. in.; cooling water to pistons, 15 lb. per sq. in. The discharge temperature of the piston cooling water was 125 deg. F., and that of the cylinder head cooling water was 120 deg. F. During the trial all lighting, heaters, and engine-room auxiliary machinery was in operation, the average electrical load being 48·4 kw. On the measured mile, with the engines developing 3,800 indicated horse-power at 130 revolutions per minute, a mean speed of 11·75 knots was obtained.

LABOUR NOTES.

Judging from the latest issue of the official organ of the British Bureau of the Red International Labour Union "Ca'canny" has no attractions for the rulers of Soviet Russia. In Russian state-owned undertakings, we are told by a writer in *The Worker*, the shop committees organise production sub-committees for the purpose of directing the work of, what are called, industrial conferences—meetings, that is,

between the administration and the rank and file for the exchange of "experiences." These sub-committees play the part of bureaus of the industrial conferences; they draw up the agenda, prepare proposals and materials for the meetings and give effect to their decisions. The industrial conferences do not interfere with the work of the administration. Their decisions are taken up by the production sub-committees which submit proposals to the administration on the basis of the decisions. If the administration disagree the proposals are then submitted to the higher union and administration bodies. The main idea of the organisation is declared to be to interest the workers in industry, and thereby "perfect and develop production."

The Russian trade union press clearly defines the duties of the trade unions in regard to industrial output. The main object of the movement is to lower the price of industrial products—to make goods cheaper. It is clear, therefore, the unions in effect, say, that "what we need is to lower the cost of labour spent in the production of every goods unit. This task must be accomplished, not, of course, through lowering wages, but through obtaining the highest effect in the productivity of labour during a time unit. It is necessary to set aside in a most resolute manner all obstacles preventing the worker from giving a maximum output and this means that all restrictions upon the amount of the workers' earnings must be removed in the first place. Also, as a rule, the basis of the pay for labour should be the grade of work and not the gradation of the wages scale to which the worker has been assigned. It is necessary to enforce piece work in preference to other rates. A similar system of stimulating labour should be applied also in the case of auxiliary labour and of the technical personnel. The unions must also, it is added, "launch a most determined struggle against absenteeism, and for the complete utilisation of the eight hours' day for productive purposes."

In the light of the foregoing, the extremists in British Trade Unionism will have to revise some of their rules, written as well as unwritten. It cannot be pleasing to them to hear that in Soviet Russia one of organised labour's aims is to reduce production costs by "obtaining the highest effect in the productivity of labour during a time unit." The enforcement of piecework and "the most determined struggle against absenteeism" are, no doubt, other unexpected and unpleasant features from their point of view. The meaning is a little obscure of the words "the basis of the pay for labour should be the grade of work and not the gradation of the wage scale to which the worker had been assigned." But it certainly seems as if Soviet Russia has hit upon a solution of the machine question which is not at all popular in engineering labour circles here.

The executive committee of the National Minority movement have adopted a new plan which will, it is hoped, appreciably increase the number of the organisation's adherents. They officially announce that they have had under consideration the best way of effecting a close personal contact with their sympathisers in the various working class organisations of the country. There are thousands of cases, they say, where sympathisers with the movement are not yet strong enough to get their trade union branches to affiliate to the minority movement. In order to get over that difficulty, it has been decided to issue an associate member's card to all who apply and pay a fee of a shilling a year. "By means of this card," the executive committee add, "we shall know where our supporters are, and what unions they belong to. It will then be possible to bring them together into definite groups in certain districts and localities. Every worker is eligible to take out this card, providing, of course, he accepts the aims and objects of the minority movement." As the aims and objects of the minority movement are far in advance of the aims and objects of most of the craft unions, it will be interesting to see how the latter take this further encroachment.

A Russian official account of the recent provincial conference of the Moscow textile workers states that the fact that many of the members of the union who are unemployed are unskilled makes the fight against unemployment very difficult. The conference proposed that the union should attempt to train those members. It is added that in this industry wages have increased more quickly than the productivity of labour. The conference, therefore, laid it down as its fundamental duty to increase the productivity of labour and bring it into proper relation to the wage-level.

Increases of wages have been granted to storehousemen, laboratory men, and storehouse assistants employed in the naval store and other supply departments, and in the civil engineering department, at H.M. Dockyards and other Admiralty establishments at home. The storehousemen and laboratory men get an advance of 4*s.* per week and the storehouse assistants an advance of 2*s.* per week. The rate of bonus payable in addition to these increases is at present 14*s.* per week. The special addition to the outport rates allowed to men employed in the London area is to continue to be payable in addition to the rates as revised.

The returns compiled by the Chief Registrar of Friendly Societies and the Ministry of Labour show that at the end of 1923 the total number of trade unions was 1,135, as compared with 1,176 in December, 1922, the reduction being due partly to dissolutions and partly to amalgamations. The number of unions dissolved was 39, with an aggregate membership of over 6,300 at the end of 1922; and 24 were affected by amalgamations in which their number was reduced to 8. On the other hand, 14 new unions, with a total membership of 7,100, were reported as formed during the year. The total membership at the end of 1923 was approximately 5,405,000, as compared with 5,610,000 at the end of 1922, showing a decrease of 205,000, or 3·7 per cent. The number of male members was about 4,590,000 giving a decrease during the twelve months of 152,000, or 3·2 per cent., and the number of female members was 815,000, representing a fall of 53,000, or 6·1 per cent. The total of 5,405,000 includes about 29,000 members in Irish Free State branches, and 65,000 members in other overseas branches of certain unions, in addition to a number of persons (principally teachers) who are members of more than one society, and are therefore counted more than once in the figures. When allowance is made for these cases the net number of members in Great Britain and Northern Ireland appears to have been nearly 5,300,000 at the end of 1923, as compared with about 5,500,000 at the end of 1922.

Nearly all the main groups of unions sustained reductions in membership last year, the principal exceptions being the mining and quarrying group, in which there was an increase of 70,000 (over 8 per cent.), and the railway group, which showed an increase of 35,000 (nearly 8 per cent.). The greatest reductions were in the metal, engineering, and shipbuilding group, in which the membership fell by 133,000, or about 16 per cent. Other groups showing heavy reductions were builders' labourers (10,000 or over 17 per cent.), agriculture (13,000), and pottery and glass (6,000), both over 14 per cent., general labour (51,000), and linen and jute (4,000), both over 10 per cent. In some groups the reductions were comparatively small, the bleaching, finishing, &c., hosiery, woodworking, and furnishing, banking and insurance, and public administration groups all showing decreases of less than 3 per cent., while in the paper, printing, &c., groups the decrease was only 0·1 per cent. The road transport and dock labour, &c., group and the boot and shoe group showed small increases. The total female membership of all groups showed a larger proportional decrease in 1923 than the total male membership, mainly due to a heavy reduction (over 26,000, or 10·4 per cent.) in female membership in the cotton industry, in which there is a preponderance of female workers. The reduction in female membership in this industry accounted for one-half of the total reduction in the female membership of all trade unions in 1923.

The Ministry of Labour reports that the number of unemployed persons on the registers of Employment Exchanges in Great Britain on October 27, 1924, was 1,203,100—910,500 men, 35,600 boys, 225,100 women and 31,900 girls. On October 20, 1924, the number of unemployed persons was 1,204,078—909,671 men, 35,464 boys, 226,793 women and 32,150 girls—and on December 31, 1923, 1,285,623—946,521 men, 36,659 boys, 267,373 women, and 35,070 girls.

The deputation appointed by the General Council of the British Trades Union Congress, to visit Russia is to leave London this week-end. The main idea is to return the fraternal visit of M. Tomsky and others to the Hull Congress, but it is proposed, in addition, to inquire into the social and economic conditions of Soviet Russia and the position of the Russian trade unions.

It is understood that the French draft decree on the subject of an eight hours' day for seamen contemplates a reversion in the case of liners to the provisions of the decree of August, 1922. There will be three complete eight hour shifts, that is, but more than eight hours may be worked when the duty does not mean effective work. On board cargo vessels permission may be obtained to do more than eight hours' duty, but every hour worked over the eight is to be paid for at overtime rates.

The tribunal recently set up for the purpose of considering various questions—including an application by the men for an increase of wages—affecting the tramways industry issued its report on November 4. The tribunal is made up of representatives of the employers and the employees, with Sir William Mackenzie as chairman. The decision and report are signed by all the members of the tribunal, and the report reviews at length the present position, the circumstances of the application, and the cases presented by the respective sides. The groupings and gradings for the purpose of fixing day work rates of wages, which the tribunal submits in its scheme for the several classes enumerated, are governed by the following factors:—(1) That no employee shall suffer a reduction of wages; (2) That no employee shall, as a result of any adjustment pursuant to the decision, receive a weekly increase of wages in excess of 1*s.* 6*d.*; (3) That present rates be calculated to the nearest 6*d.* The decision affects 142 undertakings in England, Wales, Scotland, and Northern Ireland, 90 of which are owned by municipalities and 52 by companies.

Semi-skilled and non-skilled men employed in the depots and running sheds stand, the tribunal states, on a different footing from the other employees. It is, therefore, recommended that they be classified under three grades. The following are the weekly wages payable to adult male employees under each grade in each group (except non-classified authorities), subject to the limiting factors. The working week for day work is the normal working week in each undertaking:—

Group.	Grade 1 (Weekly Rate, Day Work).	Grade 2 (Weekly Rate, Day Work).	Grade 3 (Weekly Rate, Day Work).
	s. d.	*s. d.*	*s. d.*
1	63 6	59 6	56 0
2	63 6	59 6	56 0
3	61 6	57 3	54 0
4	58 6	56 6	54 0
5	56 6	54 6	52 0
6	56 6	54 6	52 0

For night work the normal week is 48 hours, and the rate is the day work weekly rate as augmented by paragraph 53. Paragraph 53 is as follows:—"The tribunal recommend that 4*s.* per normal week, as an added or extra rate, be paid for night work over the corresponding weekly wage, paid for the same class of work done by day in undertakings outside the Metropolitan area, and 6*s.* per normal week in undertakings inside the Metropolitan area."

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—The outcome of the General Election has resulted in the revival of an optimistic feeling in the staple industries of South Yorkshire. The heavy steel trades have undergone little actual change, but though business is still at a low ebb, the position generally is sounder as compared with six months ago. The output of steel from this district though substantially below normal, is showing signs of recovery. Railway departments are not working at full capacity, but if contemplated schemes in connection with railway development in this and other countries are put into operation, there is no reason why this branch of local industry should not reap considerable benefit. Makers of axles, wheels and tyres continue to be dependent mainly on colliery repair work, but an improvement is looked for in the near future. Other branches such as shipbuilding and automobile steel manufacture are still suffering from a restrained demand. An increased demand for implements and machinery is reported from the Colonies, but business is mostly confined to essential agricultural requirements. Electrical engineers report a slight improvement and look ahead with increased optimism, especially owing to the expectation that big power development and railway electrification schemes are likely to be put into operation. The lighter trades are experiencing better times, and the position at some works resembles that of pre-war periods. The call for most classes of tools is healthier, both on home and foreign account. Competition from Germany is not so pronounced, and some of the local manufacturers are able to turn out products at prices below those of Solingen manufacture.

South Yorkshire Coal Trade.—Though an early improvement is looked for, the position generally shows no change. Best steams continue to be in strong demand for home consumption, but the amount going away for shipment is far below the average. Cobbles and nuts are selling better, but big surpluses at sidings have yet to be disposed of. Slacks display a fresh weakness, though better quality slacks are in request. Business in house coal section shows a tendency of falling off. A revival is anticipated when the year is more advanced. Foundry and furnace coke are only moderate, and gas coke remains unchanged. Quotations: Best branch hand-picked, 32*s.* to 35*s.*; Barnsley-best Silkstone, 26*s.* to 28*s.*; Derbyshire best brights, 27*s.* to 32*s.*; Derbyshire best house, 24*s.* to 26*s.*; Derbyshire best large nuts, 22*s.* 6*d.* to 25*s.*; Derbyshire best small nuts, 14*s.* to 16*s.*; Yorkshire hards, 21*s.* 6*d.* to 23*s.* 6*d.*; Derbyshire hards, 21*s.* to 23*s.*; rough slacks, 9*s.* 6*d.* to 12*s.*; nutty slacks, 9*s.* to 11*s.*; smalls, 6*s.* to 8*s.* 6*d.*

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Cleveland pig-iron is becoming scarce after the recent substantial sales, and there is indication that demand will necessitate early increase of output. Values are steadily advancing, but fear is entertained that continued rise may check business. There is a feeling that, at round about current rates, gradual expansion of trade may be reasonably looked for. That the outlook is regarded as decidedly brighter is emphasised by the fact that sellers ask more for forward delivery than the following rates, which rule for early supply: No. 1 quality, 80*s.*; No. 3 g.m.b., 81*s.*; No. 4 foundry, 80*s.*; and No. 4 forge, 79*s.*

Hematite.—Though supply of East Coast hematite continues more than ample, prices are moving upward, and further heavy sales are anticipated. Nos. 1, 2, and 3 are now quoted 88*s.* to 88*s.* 6*d.*, and No. 1 is put at 6*d.* above mixed numbers.

Foreign Ore.—Imported ore is still difficult to dispose of, but quotations are advancing. Sellers are taking quite a firm stand, and base market rates on best rubio at 22*s.* 6*d.* c.i.f. Tees.

Blast-furnace Coke.—Durham blast-furnace coke, of good medium quality, remains at 25*s.* delivered to users in this district, and it is in only moderate request.

Manufactured Iron and Steel.—In finished iron and steel Continental competition has still to be contended with, but there are indications that it is becoming somewhat less keen. Principal market quotations stand:—Common iron bars, 12*l.*; iron rivets, 14*l.*; packing (parallel), 9*l.*; packing (tapered), 12*l.*; steel billets (soft), 8*l.* 10*s.*; steel billets (medium), 9*l.*; steel billets (hard), 9*l.* 10*s.*; steel boiler plates, 13*l.*; steel ship, bridge and tank plates, 9*l.* 15*s.*; steel angles, 9*l.* 10*s.*; steel joists, 9*l.* 10*s.*; heavy steel rails, 9*l.*; fish plates, 13*l.*; and galvanised corrugated sheets, 17*l.* 10*s.*

Iron and Steel Imports.—Returns issued this week give the imports of iron and steel to the Tees from Holland, Belgium, France, Norway, Sweden, Germany, India, and coastwise, for the year ending October 31, as compared with quantities for the same time twelve months ago, and for the corresponding pre-war period of 1913–14. During the past year, 24,683 tons of pig-iron were imported, as against 14,817 tons a year ago and 1,427 tons in the pre-war period. Crude sheets, bars, billets, blooms, and slabs unloaded to the end of last month reached 95,077 tons, as against 77,931 tons a year ago and 33,655 tons in the pre-war period. Plates, bars, angles, rails, and joists unshipped during the past twelve months amounted to 20,974 tons, as against 11,371 tons a year ago and 19,482 tons in the pre-war period.

Shipments of Iron and Steel.—Shipments of iron and steel from the Tees last month totalled 105,499 tons, as compared with 75,122 tons in September, and during the previous five months they had not reached 100,000 tons. October loadings were composed of 44,877 tons of pig-iron, of which 16,543 tons went coastwise and 28,334 tons went overseas; of 8,144 tons of manufactured iron, of which 5,609 tons went coastwise and 2,535 tons went abroad; and of 52,478 tons of steel, of which 13,746 tons went coastwise and 38,732 tons went to foreign ports. Of the pig-iron despatched, Scotland received 13,628 tons, Italy 8,150 tons, the United States 4,835 tons, Germany 2,726 tons, Sweden 2,664 tons, Wales 2,050 tons, and France 1,947 tons. Natal was the best customer for manufactured iron, taking 1,294 tons. Principal importers of steel were: India, 6,666 tons; West Australia, 5,689 tons; the Argentine, 3,224 tons; New South Wales, 2,705 tons; China, 2,090 tons; and South Australia, 1,922 tons.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—There is a better undertone in the Scottish steel trade this week, but so far business has not improved. Inquiries show a tendency to increase, but the keen competitive offers from outside makers prevent local producers securing many contracts, and until costs in this district can be reduced there seems little chance of much improvement. The demand for plates and sections, while slightly better since prices were reduced, is, nevertheless, very poor. Black sheet makers are still well employed on the lighter gauges, but there is little call for the heavier gauges, while the galvanised sorts are the turn easier, although prices are down. The general export side of the steel industry is decidedly poor. The following are the market quotations forho me delivery:—Boiler plates, 13*l.* per ton; ship plates, 9*l.* 15*s.* per ton; sections, 9*l.* 10*s.* per ton; and sheets, $\frac{1}{16}$ to $\frac{1}{8}$ in., 12*l.* per ton, all delivered Glasgow stations.

Malleable Iron Trade.—Quietness is still very prevalent in the malleable-iron trade of the West of Scotland, and movement is very limited. Fresh business is extremely difficult to pick up, and the outlook is not encouraging despite prices being easier. The state of the re-rolled steel bar branch of the industry is also much quieter. The current quotation for "crown" bars is 12*l.* per ton, delivered Glasgow stations.

Scottish Pig-iron Trade.—No change of any kind can be reported in the Scottish pig-iron trade, but an improvement in inquiry has been more noticeable of late. The output is still more than equal to the demand, but there is a quiet confident feeling that a change for the better may come along in the near future. Prices are steady and the following are to-day's market quotations:—Hematite, 4*l.* 15*s.* per ton, delivered at the steel works; foundry iron, No. 1, 4*l.* 15*s.* per ton, and No. 3, 4*l.* 10*s.* per ton, both on trucks at makers' yards.

Scottish Shipbuilding.—The shipbuilding returns for the various Scottish districts for the months of October are very satisfactory, and show that active conditions have been very general. The total output for the month was 24 vessels of 92,391 tons, made up as follows:—

	Vessels.	Tons.
The Clyde	18	84,104
The Forth	2	3,207
The Tay	1	3,000
The Dee and Moray Firth	3	2,080
Total	24	92,391

Although the tonnage launched has been good for the past three months, it is the future which gives concern to the shipbuilders. New contracts are still very scarce, and only some nine vessels were reported as having been fixed up during the past month, and all of these for Clyde yards. An improvement in this direction is an absolute necessity if employment in the yards is to be maintained, but owing to the present high cost of construction the price of new tonnage is too high for shipowners to enter the market, except where actual necessity exists. The Clyde output for the past month is easily the highest for the year, and indeed it is the largest October tonnage for the past twenty years. It brings the figures for the ten months up to 183 vessels of 459,761 tons, which compares with 167,241 tons for the same period of last year and with the total of 559,834 tons for the ten months of the record year 1913. It is thus short by 100,000 tons of the figures for the latter year, and has only been bettered on six occasions since the year 1904.

Scottish Pig-Iron Shipments.—The shipment of Scottish pig-iron from Glasgow Harbour for the week ended last Saturday, November 1, amounted to 1,187 tons. Of that total 912 tons went foreign and 275 tons went coastwise. For the corresponding week of last year the figures were 1,837 tons foreign and 345 tons coastwise, making a total shipment of 2,182 tons.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Coal Trade.—The joint accountants of the coal owners and miners in the South Wales coal trade, in their report for September, show a heavy loss per ton on the total quantity raised, which was also the case in the previous four months. Since the new wages agreement came into operation in May last the working of the industry has shown a loss in each month. Previous to that the periodical audits showed a profit, but the greater cost created by the new agreement coupled with the trade depression has turned a profit into a loss. The loss per ton in September amounted to 10·07*d.*, compared with a loss of 1*s.* 3·63*d.* in August, 0·01*d.* in July and 1*s.* 4·90*d.* in June. On the 15,134,115 tons of coal raised in the four months ended September, the average loss has been approximately 10*d.* per ton, representing an aggregate loss to the industry of 629,843*l.* The proceeds during the period amounted to 14,325,875*l.*, and the costs to 14,955,718*l.*, made up as follows:—

Proceeds...		14,325,875*l.*
Costs—		
Wages... ...	10,077,505*l.*	
Other costs	4,878,213*l.*	
		14,955,718*l.*
	Loss ...	629,843*l.*

The deficit is at the rate of over 1,800,000*l.* per annum, and is unprecedented in the history of the industry. The general wage rate certified for November is 17·6 per cent. compared with 16·08 per cent. in August, so that the miners' wages will remain at the minimum of 42·22 per cent. on the 1915 standard. The difference between the wages certified and to be paid is 24·62 per cent., and to provide this the owners are compelled to sacrifice the whole of their share of the surplus and their standard profits. This sacrifice will not be sufficient to meet the minimum, and the difference must be met by using the financial reserves of the companies or by loans from bankers. In September the pithead price was improved by nearly 1*d.* per ton, and as a result of a larger output there was a reduction in the labour cost of 2*d.* per ton, and in other costs of 2½*d.* per ton. The September output was, however, nearly 500,000 tons below the average output in a month when work is not interrupted by holidays. In the four months ended September last, the output at 15,130,000 tons was 2,870,000 tons less than in the corresponding period of 1913 when the wages bill at 6,900,000*l.* was 3,390,000*l.* less than the wages bill for the smaller quantity of coal produced this year. Meanwhile the coal market has shown an improved position. The fact that collieries have been working short time, and that a number of pits are idle, has, however, prevented prices from rising. The tone is certainly steady, and salesmen are not now so ready to modify their quotations as they were a week or so ago. Best steam smalls are decidedly firmer, with supplies scarce and difficult to secure. For the best bunkers up to 17*s.* is asked, with supplies obtainable at 16*s.* 6*d.* Buyers prepared to take large as well, however, could secure a small concession. Large coals were irregular, with values dependent on individual circumstances in each particular case.

NOTICES OF MEETINGS.

THE INSTITUTION OF MECHANICAL ENGINEERS.—To-night at 6 p.m., at Storey's-gate, S.W.1. Thomas Hawksley Lecture:—"The Trend of Development of Marine Propelling Machinery," by Eng. Vice-Admiral Sir George G. Goodwin, K.C.B., LL.D. Friday, November 14, at 7 p.m. Informal meeting. "Driving Belts and Ropes." Introduced by Mr. D. N. Hunt.

THE JUNIOR INSTITUTION OF ENGINEERS.—To-night at 7.30 p.m., at 39, Victoria-street, S.W.1. Lecturette: "History and Construction of the Fire Engine," by Mr. H. C. Jones. Friday, November 14, at 7 p.m. Annual general meeting.

THE KEIGHLEY ASSOCIATION OF ENGINEERS.—Saturday, November 8, at 6.30 p.m., at the Cycling Club, Cavendish-street, Keighley. "How the Cast-Iron Research Association can Help the Engineer," by J. G. Pearce, B.Sc.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Monday, November 10, at 7 p.m., at Victoria-embankment, W.C.2. Informal Meeting. Discussion on "Research in the Cable Industry," opened by Mr. P. Dunsheath.

THE INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—Monday, November 10, at 7.30 p.m., at the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "An Outline of the Process of Casting in Bronze by the 'Cire Perdue' Method." By Mr. C. E. Henshaw.

THE INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—Tuesday, November 11, at 7.30 p.m., at 207, Bath-street, Glasgow. Inaugural Address by Mr. Alex. Lindsay.

THE NEWCOMEN SOCIETY.—Wednesday, November 12, at Caxton Hall, Westminster, S.W.1. Annual General Meeting, followed by paper, "Some Original Models of Smeaton's Eddystone Lighthouse," by Mr. Thomas Rowatt, M.I.Mech.E.

THE WOMEN'S ENGINEERING SOCIETY.—Wednesday, November 12, at 4.30 p.m., at 1, Upper Brook-street, W.1. To discuss the formation of a Women's Electrical Association.

THE ROYAL SOCIETY OF ARTS.—Wednesday, November 12, at 8 p.m., at John-street, Adelphi, W.C.2. "The Motor Car: Its Birth, its Present, and its Future," by Colonel R. E. Crompton, C.B., R.E., M.Inst.C.E.

THE INSTITUTION OF ENGINEERING INSPECTION.—Thursday, November 13, at 5.30 p.m., at the Royal Society of Arts, John-street, Adelphi, W.C.2. "The Development of Long and Short Wave Wireless Signalling," by Mr. A. P. Welch.

THE INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Thursday, November 13, at 6 p.m., at the Birmingham Chamber of Commerce. "Pipes and Pipe Lines," by Mr. T. Stafford Griffin.

THE INSTITUTE OF METALS: LONDON LOCAL SECTION.—Thursday, November 13, at 7.30 p.m., at the Royal School of Mines, South Kensington, S.W.7. "The Oxidation of Metals, with Special Reference to Thin Films," by Professor T. Turner, M.Sc., A.R.S.M.

THE OPTICAL SOCIETY.—Thursday, November 13, at 7.30 p.m., at the Imperial College of Science and Technology, South Kensington, S.W.7. "The Back Vertex Power of a Combination of Lenses," by Mr. T. Smith, M.A., F.Inst.P. "The Theory of Neutralisation," by Mr. T. Smith, M.A., F.Inst.P. "A New Type of Nephelometer," by Mr. R. Kingslake, A.R.C.S., B.Sc.

THE DIESEL ENGINE USERS' ASSOCIATION.—Friday, November 14, at the Engineers' Club, Coventry street, W.1. Discussion of Report of the Committee on Heavy-Oil Engine Working Costs.

THE MANCHESTER ASSOCIATION OF ENGINEERS.—Friday, November 14, at the Engineers' Club, Albert square, Manchester. "The Practical Significance of the Inner Structure of Metals," by Messrs. W. E. W. Millington, M.Inst.C.E., and F. C. Thompson, B.Sc., D.Met.

THE INSTITUTE OF METALS: SWANSEA LOCAL SECTION.—Friday, November 14, at 7.15 p.m., at the University College, Singleton-park, Swansea. "The Inner Structure of Alloys," by Dr. W. Rosenhain, F.R.S.

THE NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Friday, November 14, at 7.30 p.m. at Bolbec Hall, Newcastle-on-Tyne. "Girders in Ships," by Mr. J. Foster King.

THE HULL ASSOCIATION OF ENGINEERS.—Saturday, November 15, at 7.15 p.m., at the Municipal Technical College, Park-street, Hull. Lecture:—"Case Hardening," by Mr. P. B. Henshaw.

DANISH NAVAL DISARMAMENT.—It was reported some time ago in the daily papers that the Danish Government had decided on a measure which was practically equivalent to naval disarmament. Details of the scheme are now available. Henceforth the Danish fleet is to consist of ten small vessels, of between 800 and 1,500 tons, which are to guard the fisheries, patrol territorial waters, and undertake hydrographic surveying. These ships are to be supplemented by 12 seaplanes. The corps of officers is to number about 84, including non-executives. The Ministry of Marine will be abolished and a maritime police service, attached to the Ministry of State, will take its place. It is estimated that the annual cost of the new service will be about 6,000,000 kroner, which is equivalent to about 2,300,000*l.*

THE PAGEFIELD SYSTEM OF REFUSE COLLECTION.

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(*For Description, see Page* 655.)

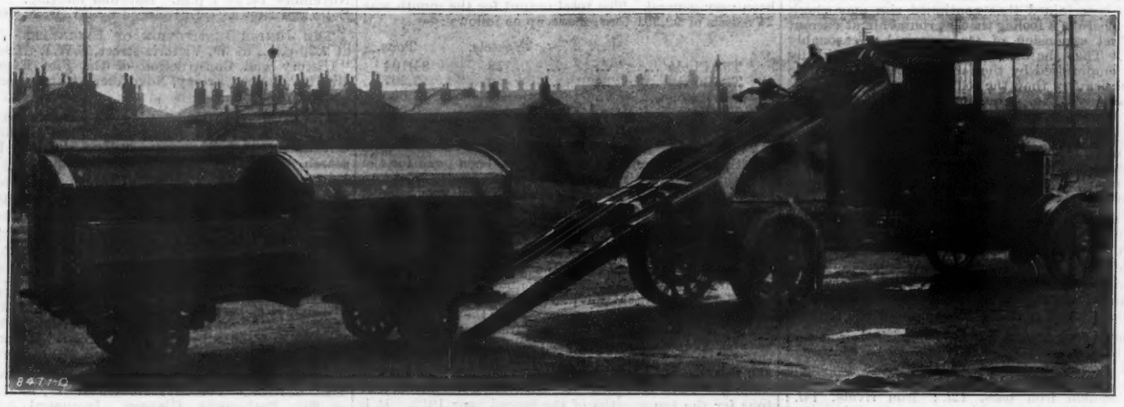

FIG. 1. CONTAINER READY FOR LOADING ON MOTOR VEHICLE.

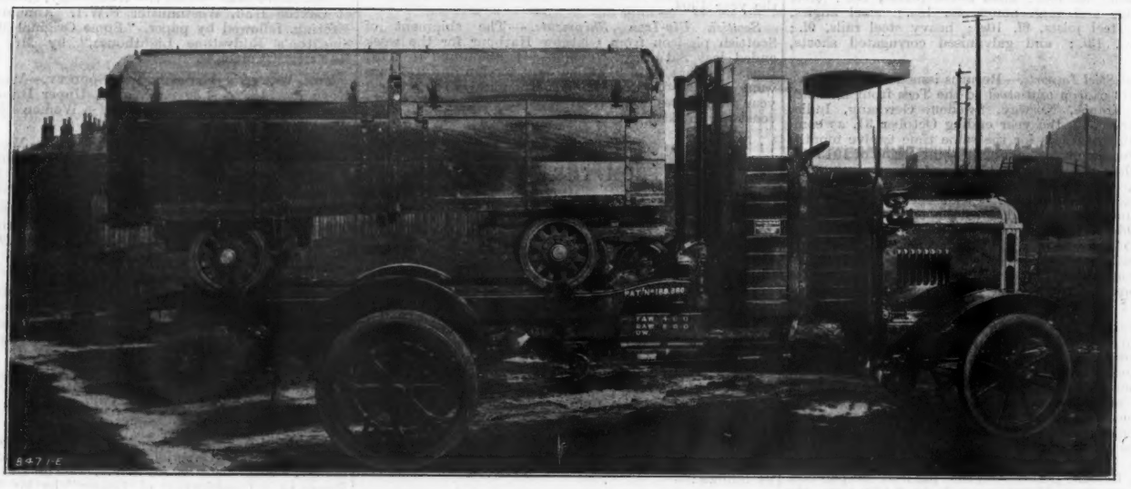

FIG. 2. CONTAINER ON MOTOR VEHICLE.

FIG. 3. CONTAINER IN TIPPING POSITION.

(To face page 634.)

THE SANTA CHIARA DI ULA DAM ON THE TIRSO RIVER, SARDINIA.

(*For Description, see Page* 632.)

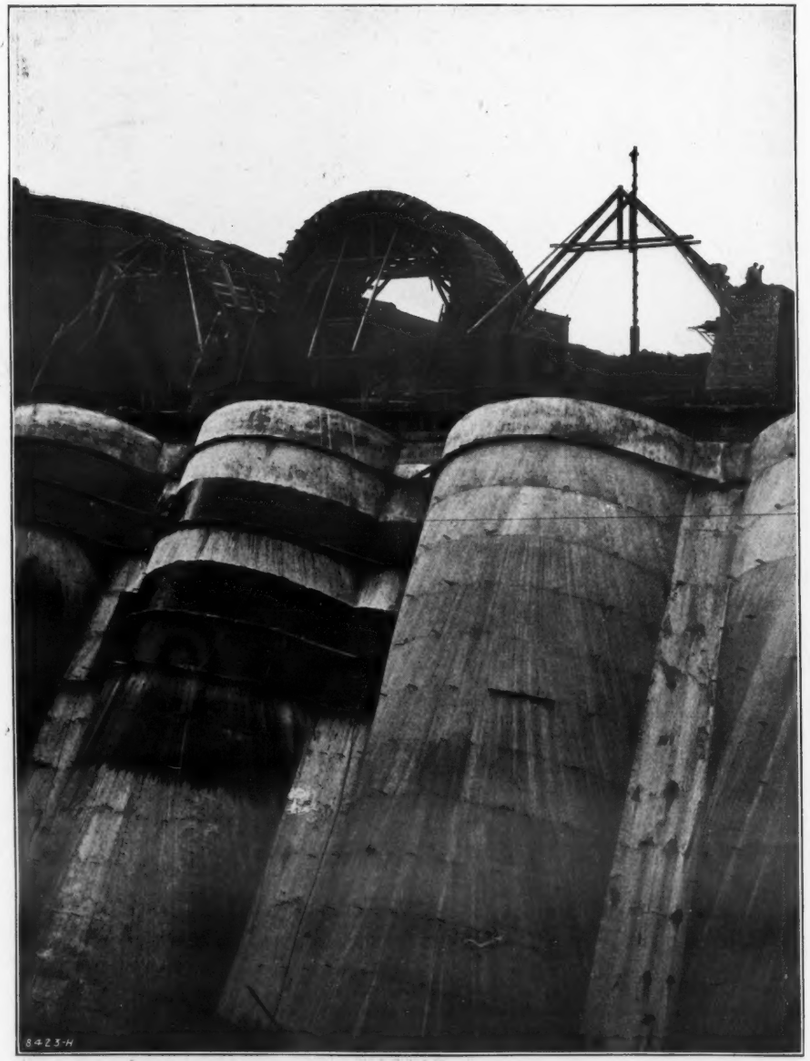

FIG. 7. VIEW SHOWING MULTIPLE ARCH DECKING.

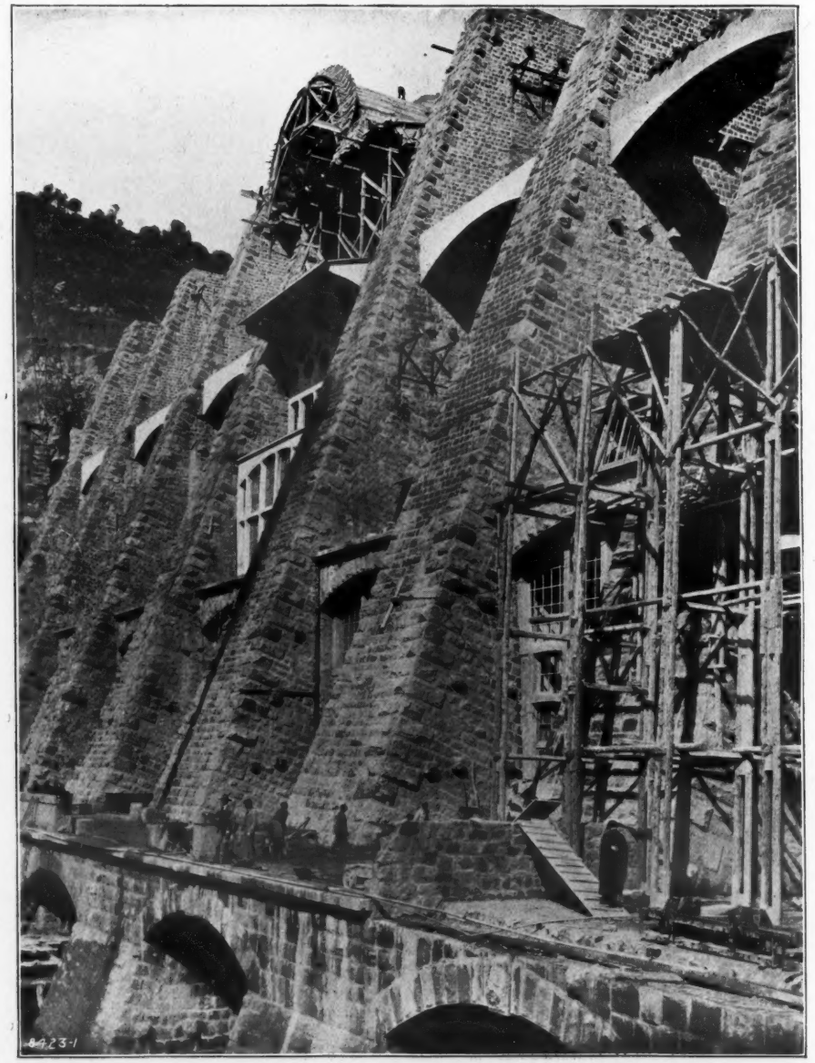

FIG. 8. DOWNSTREAM FACE OF BUTTRESSES DURING CONSTRUCTION.

THE SANTA CHIARA DI ULA DAM ON THE TIRSO RIVER, SARDINIA.

(*For Description, see Page* 632.)

FIG. 9. VIEW FROM WEST BANK DURING CONSTRUCTION.

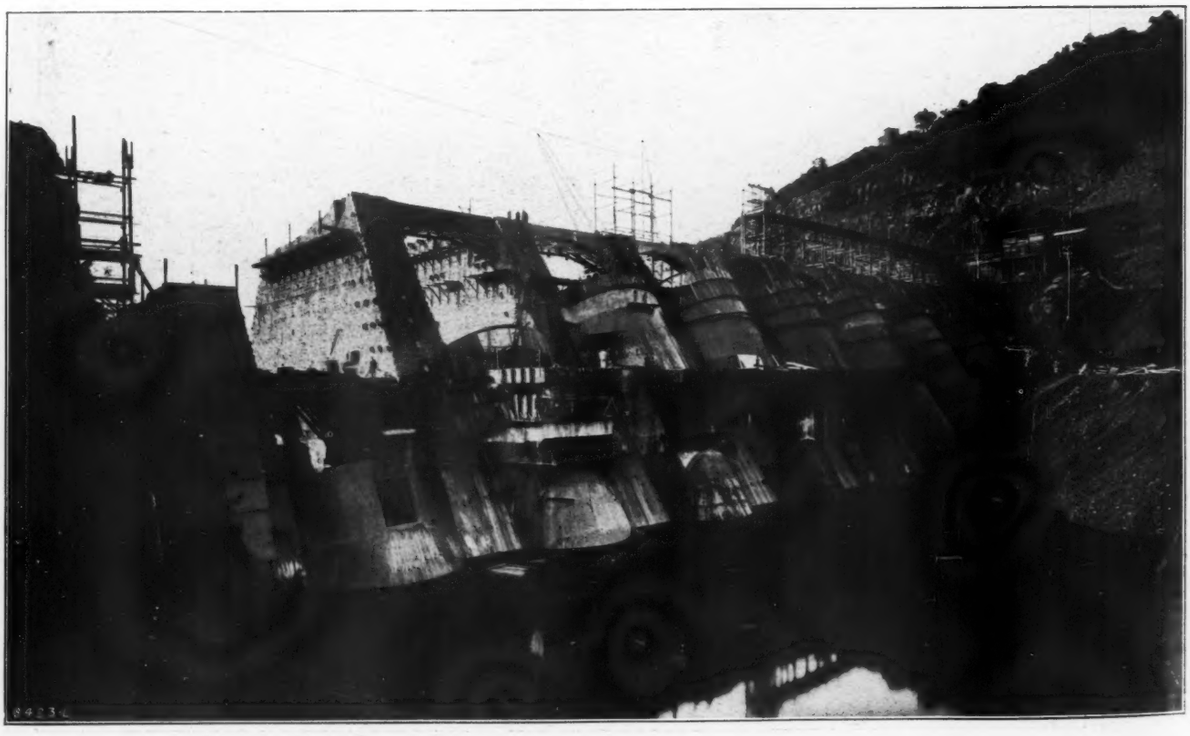

FIG. 10. VIEW DURING EARLY STAGE OF CONSTRUCTION, SHOWING INTAKES.

THE SANTA CHIARA DI ULA DAM ON THE TIRSO RIVER, SARDINIA.

(*For Description, see Page* 632.)

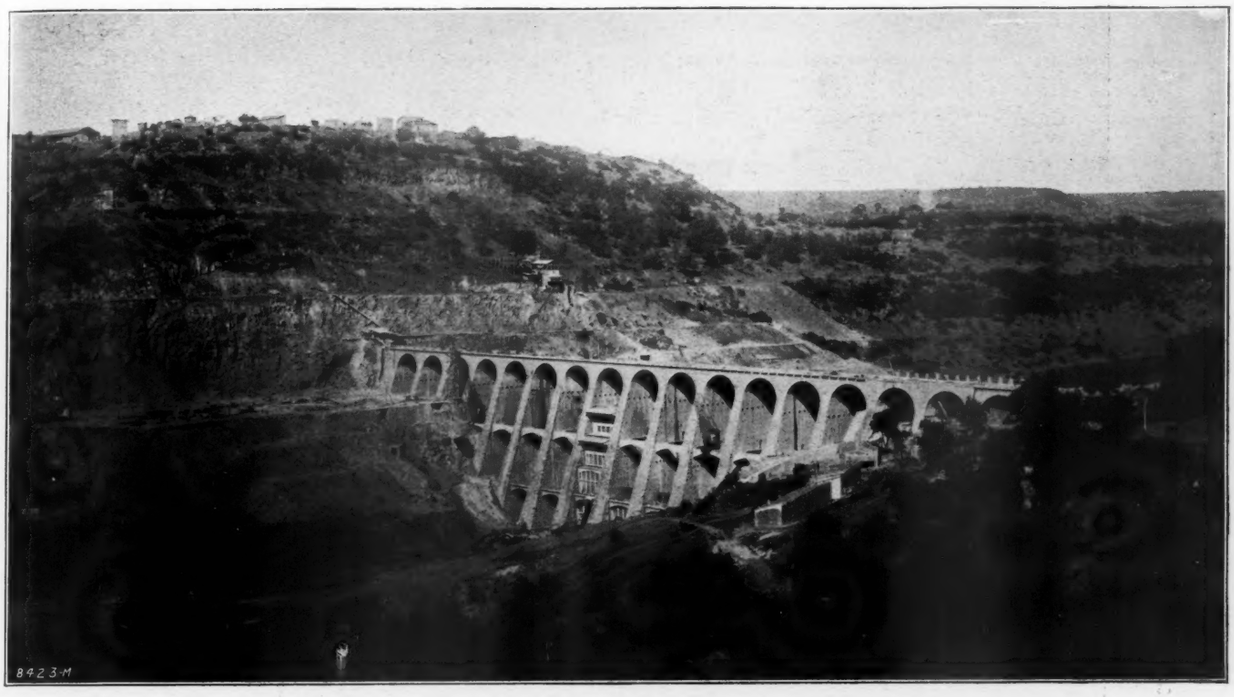

FIG. 11. DOWN-STREAM FACE OF COMPLETED DAM AS SEEN FROM EAST BANK.

FIG. 12. VIEW FROM WEST BANK SHOWING DISCHARGE CHANNELS ON EAST BANK.

THE SANTA CHIARA DI ULA DAM ON THE TIRSO RIVER, SARDINIA.

(*For Description, see Page* 632.)

FIG. 13. VIEW LOOKING DOWN ON HIGH LEVEL ROAD; DAM NEARING COMPLETION.

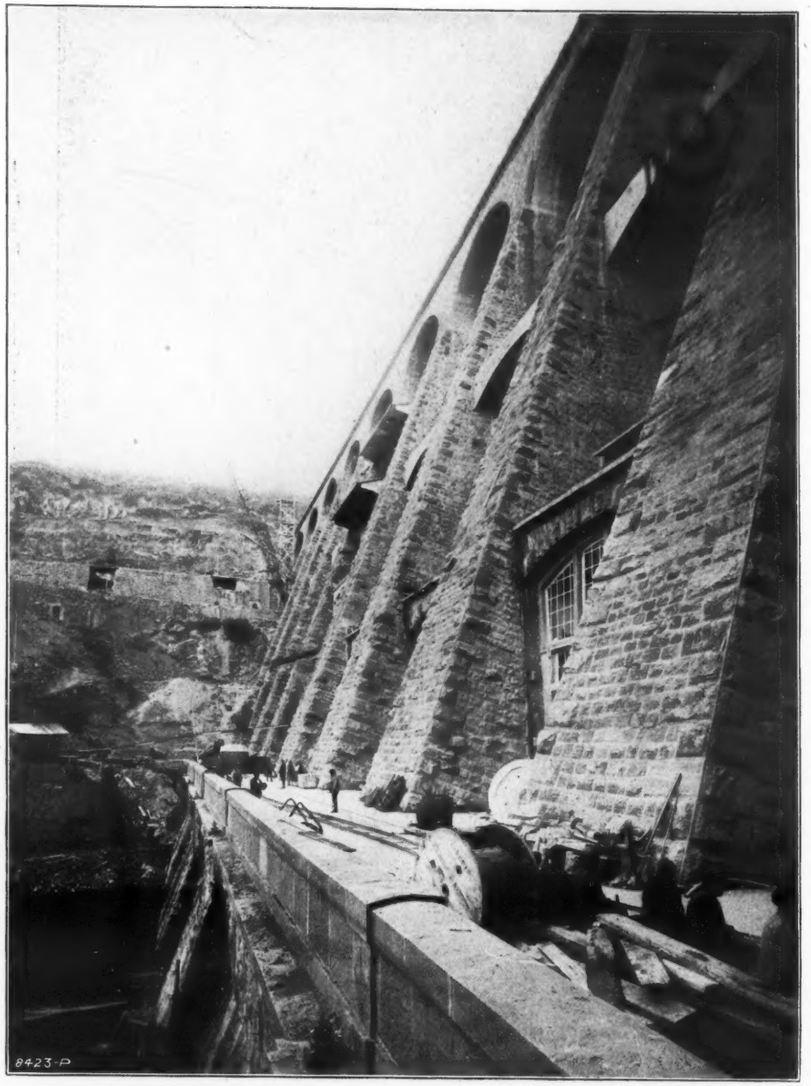

FIG. 14. THE COMPLETED DAM; VIEW OF DOWN-STREAM FACE, SHOWING LOW LEVEL ROADWAY.

(*To face page* 635.)

ENGINEERING.

Offices for Publication and Advertisements, 35 and 36, Bedford Street, Strand, London, W.C.2.

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Advertisements intended for insertion in the current week's issue must be delivered not later than First Post on Thursday. In consequence of the necessity of going to press early with a portion of the edition, alterations for standing advertisements should be received 10 days previous to the day of publication.

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Four One-Page Plates.—THE SANTA CHIARA DI ULA DAM ON THE TIRSO RIVER, SARDINIA.

ENGINEERING.

FRIDAY, NOVEMBER 7, 1924.

PROBLEMS IN METROPOLITAN ENGINEERING.

"I TELL you that, which you yourselves do know," said Mark Antony in his famous oration, but great as was the success attending his speech, the procedure is not one to be followed by the general, since, as developed by them, it is apt to result in platitudinous paraphrases of the commonplace. In striking contrast to the course pursued by Shakespeare's hero, stands the method followed by Mr. Basil Mott, C.B., in the presidential address he delivered to the Institution of Civil Engineers on Tuesday evening last. The special merit of this lies in the circumstance that the speaker drew on his long and varied experience for facts and observations, which must have been entirely novel to the vast majority of his auditors. It is, of course, impracticable for us to comment here upon all the interesting topics covered in the address, but our readers will find a very full abstract of it on page 640, and we can assure them that the trouble of a perusal will be very fully repaid. They will find there some highly informative notes on the history of the Underground Railways and the Tubes, and also remarkable instances of the strikingly erroneous estimates in vogue fifty years ago as to the possible development of the travel habit. Mr. Mott also made some valuable contributions to our existing stock of engineering data. Some of the observations recorded stand in somewhat sharp conflict with statements frequently made in our pocket books and textbooks, and this disagreement undoubtedly adds to their significance. It has, for example, frequently been asserted that the endurance of timber is unlimited, provided it be kept constantly wet with fresh water. Some notable cases of very long life under such conditions are undoubtedly well established. Indeed, when the piles driven by the Romans in bridging the Tyne were drawn, about the middle of last century, they were found to be still sound after an immersion of nearly 1,800 years. Mr. Mott, however, from observations on our London bridges, does not credit the wooden platforms, on which they have to a large extent been founded, with an endurance of more than a century. At the same time, he states that the piles supporting these platforms were found in good condition, and it would seem, therefore, that this question of the endurance of submerged timber is affected by the direction in which it is stressed. If it be compressed across the grain, its life may, it would seem, be comparatively short, whilst under an end load it may be indefinitely prolonged. The facts brought forward by the president are obviously of great practical importance, since, in America in particular, many important bridges have been founded on timber caissons, in which the timber is stressed transversely to the grain. Judging from the facts which Mr. Mott has now recorded, the endurance of these foundations may quite possibly be very much less than was anticipated by their designers.

In another part of his address, Mr. Mott called attention to the very slow rate at which facilities for crossing the Thames have been improved during the past fifty years. This is especially the case with regard to road bridges. From Vauxhall to the Tower Bridges the collective width of the roadway has only been increased by 85 ft. during the period in question, and of this increase a large fraction has been monopolised by the tramways, which are notoriously not merely obstructions in themselves, but the cause of obstruction in others. The net result of the monopolisation of road space by the tramways is that, between Westminster and the Tower Bridges, the effective width of roadway available for ordinary traffic has been increased by only 20 ft. in the past hundred years.

Another highly interesting observation recorded by Mr. Mott is the fact that the rise and fall of the tide produces a variation of from ⅛ in. to ⅜ in. in the level of the bridges, and that the deformation can be traced as far from the river as St. Pauls. We believe that Milne was able to ascertain, with his seismometers, deformations in the adjacent shores produced by the tides of the channel; but no similar movement has so far as we know been hitherto detected in a tidal river. The magnitude of the displacement is, perhaps, somewhat more than would have been anticipated, and it would certainly be interesting to have the observations extended for some distance inshore of each bank. The new theory of earth pressures described by Mr. S. D. Carotters in our issue of July 4 last, page 1, would seem to provide the means for at least an approximate mathematical analysis of such observations should they ever be carried out.

The president had also much of interest to say regarding the peculiarities of the London clay, the prevalence of which has alone made commercially practicable, the construction of the tube railways. Apparently like the little girl of the familiar rhyme: "when this clay is good it is very good, but when it is bad it is horrid." It varies enormously in quality. In parts it is so stable that the metal lining might have been dispensed with, whilst elsewhere it is so plastic that a hole made in it by a rod will close up in the course of an hour. Moreover depressions filled with water bearing gravel, mud or other unsound materials occur so capriciously that little reliance can be placed on the indications furnished by bore holes.

It is curious to learn how the standard inside dimension of these tubes originated. It appears that this particular dimension of 11 ft. 8½ in., arose as accidentally as the standard gauge for railroad track of 4 ft. 8½ in. It was originally intended to construct one of the pioneer tubes with an inside diameter of 11 ft. 6 in., but after the contract was let, the traffic department wanted a little more clearance for the vehicles to be used. All that could then be conveniently done, was to pare down the width of the internal flanges of the cast-iron lining, with the result that the odd dimension thus derived became standard for all subsequent construction.

The president had much of interest to say on

the increasing street congestion of the Metropolis, pointing out that as matters stand in the City to-day Shanks's mare once again provides the most rapid means of short-distance transit. Fortunately, this holds good over limited areas only, and is no doubt largely attributable to the narrowness of the streets in the central districts, although at certain times of the day matters are nearly as bad along Piccadilly. Unless remedial measures are taken, however, it seems certain that the limits of the super-congested areas will extend, and in this connection it is interesting to note that Mr. Mott takes a more favourable view of Sir Alfred Yarrow's ingenious scheme that has been expressed by certain other authorities. Sir Alfred Yarrow, it will be remembered, proposed, at the worst crossings, to carry one line of traffic over the other on an elevated roadway. Mr. Mott suggests that it might be preferable, in some cases, to provide an underground rather than an overhead crossing, and thinks that Hyde Park-corner would be the best site for a first test of the value of the scheme. He estimates the cost at 150,000*l.* This, no doubt, is a large sum, but it seems certain that any effective relief of the traffic congestion must necessarily involve considerable capital expenditure.

THE WORKING DAY.

Many people think that the shorter their working day the healthier, happier and better off they will be. They will, it is said, have more time for recreation and self-development. Yet such assumptions are contrary to all human experience. It is notorious that hard-working men and women are commonly the healthiest and happiest. The man who works, and works hard, has hope; and he who has hope has the greatest boon of existence. Even where it is "hope deferred" he is still better off than those who experience the discontent and even despair of idleness.

Moreover, your busy man can nearly always find time both for extra work, and recreation; whereas the man with most leisure is commonly the greatest idler, puffy in mind and body through lack of thought and exercise. It may be said that previous generations had unhappy experiences of longer working hours. But no one now advocates a working day which imposes undue hardship. Moreover, unhappiness was the result not so much of the long hours as the conditions of employment, conditions which, it may be stated, were improved without nationalisation and long before politicians interfered so much with industry. If spokesmen for the workers would only concentrate on reasonable proposals for still further improving conditions of work, instead of advocating shorter working hours, they would not only find their efforts backed by a great fund of good-will among employers but would be doing the classes they claim to represent a service instead of an injury.

Another common fallacy is that happiness is only to be found in attainment. It is assumed that if men had this, that or the other thing, then indeed all would be well with their world. Given wealth, socialism or anything else which is at present beyond their reach, how blessed would be their lot! Such an attitude betrays the grossest inability to make sound deductions from experience. Happiness is found not in the goal but in the getting there. What ever rung of the ladder men reach, they restlessly desire to step on to the next. It is too often forgotten that to gain an object is to lose the hope which has hitherto spurred us on; and that our greatest happiness thereafter—next to finding some new focus for our endeavours—lies in fighting over again the battles we encountered on the way. Achievement in the material sense may mean money to invest, but no stockbroker can find us a better investment than striving, which yields a percentage in hope and pleasure limited only by our own industry.

It may be said that men seldom receive the full reward to which they are entitled, and that this destroys incentive. It is probably true that none of us get what we are worth—or what we think we are worth. Even what we get is taken away from us to an increasing degree by taxation and such like means. Yet still we find men who can work happily under these circumstances—complaining, no doubt, as one complains about the weather, but still finding life well worth living. It is all a matter of character and resolution, and men worthy of the name can rise superior even to the depredations of the tax-gatherer. A man who works and is deprived of two-thirds of his earnings is better off than one who rusts away under restricted working hours.

It is difficult to persuade some people to see matters in this light. They have been hypnotised by catch-phrases into the belief that their unhappiness is due, not to their own attitude towards life and work, but to the social system. No longer, it seems, is the kingdom of heaven to be within us, but in the system under which we work. Scepticism in the face of such a claim is at least justifiable. "Tisn't life that matters! 'Tis the courage you bring to it" says a character in a recent novel; and one may add that it is not any particular social system, but what we choose to make of it that counts. And the making is never an accomplished fact; it goes on for ever, an endless becoming as the result of endless striving. Such truths are frequently overlooked, just as in the world of sport it is too often forgotten that the object of a game is to play it, not to win it. No amount of tinkering with the social system can produce a better world so long as men fail to "play the game" in their working hours, putting forth their utmost effort for sheer joy in the striving. Only so, and not in "ca' canny" and in a miserably inadequate working day can we expect to secure peace of mind and abiding happiness.

ELECTRICAL PRECIPITATION.

The problems of "Electrical Precipitation," on which Sir Oliver Lodge discoursed in the seventh lecture on "Physics in Industry," before the Institute of Physics on October 29, were first investigated in connection with smoke abatement and meteorological phenomena. That work has led to very practical ends, and dust and fumes are being precipitated in installations all over the world to stop nuisances as well as to recover valuable products hitherto wasted. The success realised has encouraged Sir Oliver to revert to the possibility of a control of atmospheric precipitation which was given up as hopeless in the early days of his researches. Sooner or later those questions will be attacked. To understand the nature of the problems we had best follow Sir Oliver's exposition.

Every water globule, being eighty times as heavy as air, falls with a velocity depending upon its bulk and upon the air resistance which varies with the surface. Large drops do not fall as rapidly as Stokes' law requires, because they flatten out until broken up. The fine globules do not reach the earth because their convex curvature favours evaporation, while concave curvature promotes condensation; hence moisture condenses in the interstices of woollen fabrics, and our clothes become damp before the dew point is reached on a flat surface. The coalescence is assisted by electricity; but how, is not quite understood yet. In Armstrong's hydroelectric machine, drops of water or mist must rub over a solid surface to become electrified. Dry steam and dry gases will not do; steam must be condensed into a visible cloud. Any two surfaces rubbed together become electrified by friction. The theory of electrons, Sir Oliver remarked, has illuminated the process to a certain extent, but does not fully explain it.

When two surfaces were brought into contact electrons were transferred across the junction, and when the surfaces were separated again and the capacity was diminished, high potentials were set up. Between two metals in contact, a few electrons could easily cross; across junctions of two insulators enormous numbers of electrons could be forced, but the exchange might require violent rubbing. The high potentials were not surprising. Any isolated electron was at a high potential; assuming the ordinary electric law to hold, an isolated electron would carry a potential of 5,000 electrostatic units or 1,500,000 volts. The outlying electrons linking the atoms together might easily be transferred, being common property for the instant. To which atom or body they would adhere after separating was questionable; any minor factor, difference in surface roughness or in colour, might cause preponderance of transfer in one direction, and the electron might not adhere to either body, but be carried away by a puff of air. When two similar substances were rubbed together and then separated, a blast of air between them might become electrified, Sir Oliver thought, if contact had been close enough to cause adhesion.

The converse of that separation or decoherence was cohesion under electric stimulation. When two drops of water or mercury, came into so-called contact, there was usually a separating film of grease or oxide or air that had to be squeezed out. For a very feeble electromotive force, the surfaces remained insulated from one another; we had a "bad joint," the apparent capriciousness of which gave a great deal of trouble to radiotelegraphic experimenters. A bad joint was an insulator for anything below a minimum potential difference, and a conductor for anything above it, until its cohesion was broken up again by some tremor or electric fluctuation. A bad joint did not obey Ohm's law; it was a veritable discontinuity with laws of its own.

When a pool of mercury was cut in half by a slightly greasy knife, the two halves remained separated; but they re-united on being joined to a Grove cell. Similarly, two jets of clean water impinging at an angle would not unite, and the jet of water issuing from a nozzle dissolved into drops which remained separate. But the application of a potential of a volt or two made the drops coalesce and fall in blobs like the rain of a thunderstorm. Sir Oliver had shown this at the Montreal British Association meeting of 1884. To electrify the jet he brought a rubbed stick of sealing wax within a yard of it; if the stick were brought too near to the jet, electric repulsion between the drops would disperse the jet. He also found then that the infinitesimal globules of a mist would condense into rain drops when electrified. Robert Helmholtz (the son of Hermann Helmholtz) observed that the cloud of a steam jet from a kettle, looking white in the lantern beam, would darken if electricity were discharged into it.

All that was evidently electric precipitation, analogous to "natural atmospheric precipitation;" but what was the cause of the millions of volts in a thunderstorm? Solar radiations responsible for aurorae could not account for local thunderstorms. Electrification by friction between water drops and air had often been suggested. Lenard had observed that the spray at the bottom of a waterfall was electrified. The effect was weak, however, and friction between water and air did not appear to be sufficient. In 1907 Dr. G. Simpson (now director of the Meteorological Office) demonstrated that the mere breaking up of water drops by ascending air currents, which were extraordinarily strong during thunderstorms, resulted in electric charges, the water becoming positive, the air negative. Sir Oliver was ready to accept the suggestion; it was hardly to be expected theoretically, but there were no contradictory experiments. To understand it we had to look at the phenomena from the point of view of the electric influence of cohesion.

Passing to "artificial precipitation," Sir Oliver said that he and the late Mr. J. W. Clark had started their experiments in Liverpool in 1882 from the observation that the air rising from a warm water pipe appeared to be surrounded by a dark space, when illuminated by a strong beam. It had been known that the air stream rising from a hot poker or a burning spirit lamp looked black in strong light, and Tyndall had suggested that the solid dust particles, without which the beam would be invisible, were burnt out by the flame. But Rayleigh found that slight differences in temperature would set up dark currents. The dust carried by the warm currents settled on colder spots of walls and ceilings. The particles concerned, Sir Oliver ascertained, were very small, and they were kept away from the warm body by molecular bombardments. When the warm body was an electrified rod, the dark space expanded. They then electrified the smoke of oxide particles from a burning magnesium wire, confined in a bell jar, by the brush discharge from a needle

joined to one terminal of a Wimshurst machine. The smoke was rapidly cleared; the particles adhered to one another in long threads radiating from the needle point or settled on the wall. When the jar was filled with steam, the globules coalesced and came down as a fine rain. Later on Sir Oliver learnt that similar experiments on the electric brush discharge had been made by Hohlfeld in Leipzig in 1824.

At Liverpool they next tried to dispel fog by these means, and Mr. Alfred Walker attempted to settle the dust from lead works in North Wales. But the technical difficulties of high-tension alternating current generation, rectification and insulation, in those days frustrated the experiments. They were later resumed by Sir Oliver, his son, Mr. Lionel Lodge, and his assistant Mr. Robinson. Meanwhile Dr. F. G. Cottrell had been working on similar lines, and had been able to apply his process in smelting works on a large scale, while the Lodge Fume Deposit Company was started in this country. There was further friendly competition by Dr. Moeller's process of the Metallbank und Metallurgische Gesellschaft, of Frankfurt. About 200 plants were now in operation all over the world for precipitating metal and acid fumes, blast-furnace dust, and dust generally. The pressures of 100,000 volts naturally required very special insulation and safety appliances. Particulars of such installations were given in our issues of October 1, 1920, dealing with blast-furnace gas purification at the works of Messrs. Hutchinson and Bury at Skinningrove; while in that of January 28, 1921, the precipitation of sulphuric acid fumes at the R.N. Cordite Factory at Holton Heath was dealt with. At the tin-smelting works of Messrs. Williams, Harvey and Co., near Bootle, tin oxides fumes, smoke and other solids which were deposited had paid for the electrification over and over again. Precipitating efficiencies of 95 per cent. and more were attained, gases of 600 deg. C. could be treated, and 3 kw. hours would deposit 18 tons of matter, but every material required a special treatment.

Returning to natural and artificial precipitation, Sir Oliver said it was not the fashion now to leave Nature alone, but attempted to encourage and supplement her. We still supplicated the Higher Powers for the production or limitation of rain instead of setting to work and seeing what we could do ourselves. This problem was large and difficult, but it would be tackled now or by posterity. Experiments might fail, but they might give a clue. The greater part of the world suffered from drought, though that might sound strange this year. Clouds appeared even in deserts, but dispersed again without precipitation. Why not electrify them or parts of them to different potentials? Success awaited those, possibly of a future generation, who could put up with ridicule. Obstacles were rarely as insuperable as they appeared.

THE BREWERS' EXHIBITION.

THERE can be no doubt that participation in trade exhibitions is now recognised as an essential part of the selling organisation of any business. When these shows are held annually they not only provide the means of enabling the people in the trade to renew acquaintance with the standard products of any specific organisation but also make possible an estimate of yearly progress. The presentation within the same building of machines for the same purpose, designed and constructed by different firms, is of great value to all in the trade, and shows the necessity to individual designers for greater efforts, if they are to keep abreast of the rival organisations. Trade exhibitions, though limited in scope, attract the attention, practically entirely, of the people in the industry and mere sightseers do not go in such numbers as to make it difficult for the producers and purchasers to become known personally to each other. One of the oldest of these annual trade shows is the Brewers' Exhibition, the forty-first of which was opened at the Royal Agricultural Hall at Islington on Monday and remains open until to-night.

The business of brewing is largely of a chemical and bacteriological nature but the plant used is of interest from an engineering standpoint, as exemplifying the means of reducing the costs of production by the use of mechanical contrivances. Machinery for washing, filling, stoppering and labelling bottles takes many forms, each suited to specific types of work, and examples are shown in the exhibition which bear testimony to the skill of the designers in dealing with what are not always simple problems. Again, casks must be washed and handled with the expenditure of little manual labour if economy must be effected in working. Among the exhibits of such plant the "Super-Goliath" cask washer made by Messrs. G. Hopkins and Sons (Clerkenwell), Limited, of Holloway-road, London, is the most outstanding. This machine, which we described with many illustrations in a recent issue of ENGINEERING (see vol. cxvii, page 367), is used for the washing and sterilising of all types of casks, both inside and out. The internal cleansing is performed with boiling water forced into the barrels by the use of nozzles which deliver only when the control valve is operated by the load of the cask on the valve lever system. For the series of operations, the barrels are lifted by a reciprocating frame from one nozzle to the next, and are kept in such positions as ensure the accurate registering of the hole in the side of cask with the nozzles. Four centrifugal pumps are coupled in series to put the water under suitable pressures for the work, and the arrangements are such that boiling water may be delivered to the casks without the troubles caused by airlocks in the system.

Bottle-washing plant in great variety and of various capacities is another type of labour-saving machine which is exhibited. A fully automatic machine made by Messrs. L. Lumley and Co., Limited, of Letchworth, Herts, affords a good example of modern design. In this machine the processes which are performed are three in number, soaking and sterilising, brushing and rinsing. This machine was described early this year in ENGINEERING (see vol. cxvii, page 105). It is capable of dealing with 120 dozen bottles in an hour, and a conveyer is attached to it by means of which the bottles are conveyed to the filling plant.

The Brewers' Equipment Company, of Bishop-street, Birmingham, show a wheel type of bottle soaker. The wheel is fitted with an outside brush so that the inside part of the tank is cleared of labels and dirt, which would otherwise accumulate at the foot of the soaker. As it holds 65 dozen bottles at a time under water, each bottle has an immersion of over half-an-hour, when working at a rate of 120 dozen bottles per hour. A first rinser and drainer is arranged between the soaker and brusher. This returns the water to the soaker, sprays the bottles both inside and out and delivers them to the brusher part of the equipment quite empty. The brusher is fitted with many water injectors which supply fresh water to the bottles while they are being cleaned all over by carefully arranged brushes. The bottles are then placed upon the second or after rinser, which has long internal jets and the bottles, being held at the necks, are allowed free drainage.

Among the other exhibitors who show bottle-washing machines, Messrs. Dawson Bros., Limited, of Ventnor Iron Works, Gomersal, near Leeds, may be mentioned. They show an automatic washing and sterilising plant which can deal with 200 dozen bottles per hour. In this plant the bottles are soaked in a strong cleansing solution and are automatically discharged into a clean water tank. A steam coil is provided in the soaking tank to maintain a suitable temperature for the work. At the delivery side of the machine there are two galvanised steel brushing tanks fitted with an improved brushing head. Another part of the equipment consists of a power-driven automatic rinser, which has 24 gun-metal bottle holders or rinsing cups.

A complete refrigeration plant and sectioned cold storage cabinet for use where the requirements do not necessitate extensive plant, is shown by Messrs. Robert Boby, Limited, of St. Andrew's Ironworks, Bury St. Edmunds. At one side of the cabinet, a cupboard completely houses the whole of the plant. The compressor is driven by an electric motor which is situated beneath it. To allow easy starting of the electric motor the table on which it is mounted can be raised or lowered by a cam which is turned by hand lever. In this simple way the motor can be raised out of contact with the belt of the compressor and started free. Once it is running, the table can be lowered into position and the pulley of the motor brought into contact with the belt to ensure the drive to the compressor. Brine is cooled by being conveyed through pipes in the evaporator. This is conducted in the pipe system of the storage cabinet to keep the temperatures at the required values. Provision is also made for producing ice in a long, narrow and shallow trough, around which the cold brine is circulated.

Messrs. Sulzer Bros., of 31, Bedford-square, London, show an electrically-driven rotary refrigerating machine for use in association with a cooling chamber of 150 cub. ft. capacity or for ice-making. This is a self-lubricated plant which is entirely automatic in action. Units of greater capacity than that exhibited are also manufactured. The motor is installed on a platform at the top of the plant and drives the rotary compressor directly. Underneath, the evaporator is located, and the cooling coils are connected to a header at the foot. These cooling pipes are vertical and mounted in a circular row forming a cage, and they are all connected at their ends to a ring header.

An interesting example of machinery for the three purposes of introducing syrup into bottles, filling and crowning, is shown by Messrs. Bratby and Hinchcliffe, Limited, of Sandford-street, Ancoats, Manchester. The three separate machines are built up on one set of girders, and are fed with bottles quite automatically from a straight length of conveyor. The syrup plant works with a gravity feed and has twelve filling heads, while the filling machine is of the rotary counter pressure type and has 24 heads. As a complete unit the machine is capable of dealing with a bottle every second.

THE LATE SIR PERCY TEMPEST.

WE regret to record the death of Sir Percy Crosland Tempest, K.B.E., who was for so many years associated with the engineering work of the South Eastern and Chatham Railway. Sir Percy Tempest was born in Leeds on February 24, 1860, and was therefore in his 65th year at the time of his death, which took place at his residence on Monday last, after a very brief illness. He received his early education at the Leeds Grammar School, and at the age of 17 was articled for a term of three years to the late Mr. Morant, the Borough Engineer of Leeds. On the completion of his indentures he entered the service of the London and North Western Railway Company, and acted for about 18 months as an assistant engineer in connection with the construction of a loop line from Leeds to Wortley. In 1881 he came south and joined the engineering staff of the South Eastern Railway under Mr. Francis Brady, acting as resident engineer from 1891 to 1895 on the construction of the Bexley Heath line, a double track from Blackheath to Dartford. In May, 1895, he was appointed resident engineer to the South Eastern Railway. On the amalgamation which resulted in the formation of the South Eastern and Chatham Railway Company in 1899, Mr. Tempest, as he then was, was given the post of Chief Engineer, and in April, 1920, he was appointed General Manager and Chief Engineer in succession to Sir Francis Dent. When the recent great railway amalgamations came into effect and the South Eastern and Chatham Company was merged in the Southern Railway Company, Sir Percy Tempest acted as joint General Manager with Sir Herbert Walker until his retirement last year. His great experience of continental traffic naturally interested him in the Channel Tunnel Scheme, and for the past eight years he has acted as chief engineer to the Channel Tunnel Company. The consistent rejection of the project by the Naval and Military advisers of the Government, on grounds of national defence, and the lack of enthusiasm amongst the general public for any closer connection with continental nations did not shake his belief in the ultimate construction of a tunnel under the Channel, and last year he issued a memor-

andum in which he estimated that the total cost of construction would be 29,000,000*l.* and that the work could be carried out in three years. During the war Sir Percy Tempest acted as agent for the Northern Railway of France and for the Belgian State Railways, purchasing large quantities of rails, bridge material and other equipment on their behalf, and he also carried out extensive railway and civil engineering works in connection with the military base at Boulogne. For his war services he was awarded the C.B.E. in 1918 and was promoted to K.B.E. in 1923. He also received the Cross of the Order of Leopold of Belgium. Other foreign distinctions conferred upon him were the orders of a Chevalier of the Legion d'Honneur and of a Knight of the Order of the Dannebrog.

It was during Sir Percy Tempest's tenure of office as Chief Engineer to the South Eastern Railway that the serious accident occurred at Charing Cross Terminus, when several bays of the old arched roof which used to span the station collapsed and fell. He, himself, remained on the station all night and superintended the difficult and dangerous work of staying the remainder of the roof, to prevent further disaster, and it was due to his courtesy that we were able to give an accurate account of the accident in our issues of December 8 and December 29, 1905, and subsequently illustrate the details of the new roof with which the old one was replaced.

Sir Percy Tempest was elected an Associate Member of the Institution of Civil Engineers in 1886 and was transferred to full membership in 1897.

THE LATE MR. D. W. HOOD.

It is with great regret that we announce the sudden death, at the early age of 50, of Mr. David Wilson Hood, Engineer-in-Chief to the Corporation of Trinity House. Mr. Hood, whose physique would have led one to imagine that he was destined to enjoy a very considerable lease of life, died quite unexpectedly of heart failure on the 29th ult., at his residence at Hampstead.

Born on March 18, 1874, David Wilson Hood was the son of the late Mr. J. Hood, J.P., of Lilliesleaf, Roxburghshire. His early education was carried out at Daniel Stewart's College, Edinburgh, after which he attended the Heriot Watt College in that city and was pupilled to the well-known lighthouse engineering firm of Messrs. D. and C. Stevenson, a name as familiar to the reading public through the several Lives of Robert Louis Stevenson, as its reputation is in professional circles, through its long engineering connection with the Commissioners of Northern Lighthouses.

Mr. Hood remained with Messrs. D. and C. Stevenson until, in 1895, he was 21 years of age, when he entered the service of Trinity House. Sir Thomas Matthews, M.Inst.C.E., was then chief engineer, from which post, after a long record, he retired in 1915, being still, we are glad to say, in the enjoyment of the leisure he so well earned. Under Sir Thomas, Mr. Hood was first of all engaged as civil construction assistant on the preparation of plans, specifications and quantities for new lighthouses. For a long while subsequently his duties involved visiting lighthouse works in progress under contract, such as Pendeen (Cornwall), Dungeness, Portland Bill, Strumble Head, and others, as well as fog signal stations, &c. In addition to his duties in connection with the Corporation of Trinity House, he did a great deal of work connected with the Colonial and India Offices, the Admiralty and the Board of Trade, for whom a considerable number of lighthouse improvements were carried out by the engineers department of Trinity House. Mr. Hood not only designed but supervised construction and carried out the final inspection for lighthouse apparatus constructed both in English and French works.

In 1904 on the recommendation of the Elder Brethren, Mr. Hood was deputed by the Board of Trade to advise on the conditions at the Falkland Islands, and following on his report the Cape Pembroke lighthouse was constructed. Again in 1909 he was recommended to the Government of India and was appointed a member of a commission charged with the preparation of a scheme for the establishment of lighthouses and the construction of other works in the Persian Gulf.

On Sir Thomas Matthews' retirement in 1915 Mr. D. W. Hood was appointed to the position of engineer-in-chief, and rendered the Corporation very valuable service in a period full of interesting developments. The war greatly complicated the lighting and beaconing arrangements on the English coast, and Mr. Hood took up his enlarged duties just as this difficult period was commencing. That he carried through the work satisfactorily is evidenced by the fact that he was subsequently awarded a C.B.E. The later years of the war, and the period which has elapsed since have seen probably more rapid development in lighthouse and fog signalling practice than any previous period of similar length. During Mr. Hood's connection with Trinity House wick lamps have dropped out of use, their place being taken first by an incandescent

Photo. by Lena Connell.

THE LATE MR. D. W. HOOD.

burner developed by Sir Thomas Matthews, and later by an auto-form mantle burner designed by Mr. Hood. This burner was devised to reduce maintenance troubles and costs which had so increased during the later stages of the war as to make a satisfactory service a matter of much difficulty. The Hood burner and the earlier developments which led up to it were fully described in ENGINEERING in 1922 (see vol. cxiii, page 541), and we understand that further experience with it has been found to confirm all that we then said of it. The burner is a very substantial piece of work, while its intrinsic brightness is double that of the previous standard collodian mantle type.

To the optical side of his work, Mr. Hood had a devoted interest, introducing a number of improvements in which he took advantage of the latest developments. He was responsible for the adoption on a considerable scale of dissolved acetylene on light vessels and buoys, one of the most important applications being made originally for an unwatched light at the Lune Deep in Morecambe Bay. This was described by Mr. Hood in a contribution presented to the 1923 International Congress of Navigation. It is now to be placed on the Cork Light vessel. At the present time about 40 lighted buoys are supplied with dissolved acetylene, the standard arrangement being for a capacity sufficient for 12 months' lighting without recharging. In cases in which the consumption is high, and periodical attention possible, questions of cost recommend the generation of acetylene on the spot, and under Mr. Hood's direction this system has been adopted for certain lighthouses. Where continuous watch is kept, it is still found the best practice to adopt paraffin oil as the illuminant, the Hood burner being now the standard for use with this. Electricity owing to the cost of the attendance necessary, has hitherto not proved practicable for isolated lights, though recently the South Foreland lighthouse has been converted to use this source of light, the current, however, being supplied by the Dover Corporation. The light uses an $11\frac{1}{2}$-in. bulb 4-kw. gas-filled lamp of 8,000 standard candle power.

Mr. Hood was much interested in the question of the development of lights for facilitating aerial navigation and devised several arrangements combining maritime and aerial lights in the required graduation of power.

Developments in fog-signalling have also contributed to the changes made in recent years. A number of improvments in connection with bells have taken place under Mr. Hood's direction. The most interesting relate to the striking of such bells by means of stored CO_2 under pressure. A battery of cylinders sufficient for 12 months' working is fitted on some of the gas boats, the gas acting on the underside of a diaphragm which operates the hammer. Submarine bells are also now worked by CO_2 or air at a pressure of about 15 lb. In another type of submarine bell electricity is used, generated on shore in conjunction with fog-signalling compressor plant.

For the latter oil engines are used, the most recent installation—namely, that at Pendeen Lighthouse, Cornwall—comprising 48-h.p. semi-Diesel engines by Messrs. Morris, Henty and Gardner, direct-coupled to Reavell compressors of 350 cub. ft. of free air per minute capacity. As regards sound signals the latest development under Mr. Hood was the installation of diaphones at the Caskets Lighthouse off Alderney. Observations have shown these to give a signal superior to the syren, owing partly to the sharpness with which it commences and ceases, but this superiority is not apparently maintained under all conditions.

In connection with electrical improvements during recent years Mr. Hood's department has been responsible for experiments in synchronous signalling, and for the introduction of wireless telephonic communication between light vessels and the shore, as well as interested in direction finding and giving. From comparative simplicity lighthouses and light vessels have in recent years acquired quite complicated forms, with a considerable amount of mechanical plant. It is true that in many instances attendance has been reduced or abolished, but this has involved a rather more complex form of organisation and service, so that though the service itself is more efficient and more nearly perfect and relatively less costly, the improvement has been brought about by having recourse more to mechanical and scientific aids. In this work Mr. Hood was in his element, and his interest in the perfection of installations of innumerable types was very keen. He was ever ready to consider and try out thoroughly advances which gave promising indications.

In the course of the past year Mr. Hood visited the West Indies to report on improvements in lights in those waters. He was elected an associate member of the Institution of Civil Engineers in 1900, becoming a full member in 1910.

The funeral took place at Mill Hill on Saturday last, when a memorial service was also held at St. Olave's, Hart-street, E.C.

SPANISH NAVAL CONSTRUCTION.—The destroyer Alcedo, of the 1915 building programme, has been completed and handed over to the navy. Her characteristics are: Displacement, 1,145 tons; length, 283 ft.; horse-power, 33,000; speed, 34 knots; armament, three 4-in. and two 12-pounder anti-aircraft guns; four 21-in. torpedo tubes.

FACILITIES FOR STUDY OF EMPIRE RESOURCES.—The decision of the six great steamship lines engaged in the passenger service to Australia and New Zealand, to grant eight free first-class return tickets yearly to university graduates, desirous of studying problems connected with the utilisation of the resources of these countries, or of holding temporary teaching posts in them, is to be highly commended. The selection of the recipients will rest with a committee of the University Bureau of the British Empire.

NOTES.

An Electric Harmonic Analyser.

In a paper read before the Institution of Electrical Engineers last evening, Messrs. J. D. Cockcroft, R. T. Coe, J. A. Tyacke and Professor Miles Walker described a purely electrical method of determining the various harmonics which build up the wave-form of alternating currents and voltages. The method is based upon suggestions made many years ago by the late Professor John Perry, who pointed out that the reading of a watt meter of the dynamometer type depended upon the average value of the product obtained in multiplying the strength of the current in the one coil by that in the other. Hence, if one of the coils was traversed by a pure sine wave current, and the other coil by a complex wave current, the reading of the instrument would be proportional to the Fourier coefficient of the corresponding harmonic of the complex wave. By prolonged experiment the authors of the paper have succeeded in practicalising this suggestion, and in producing a portable instrument which will give all the Fourier coefficients up to the 23rd of any alternating current or voltage with a maximum error of well under 1 per cent.

The Soviet Naval Building Programme.

It has been known for some time past that the Soviet Government has been making efforts to re-organise its naval forces. During the last two years manœuvres have been carried out in the Baltic which, though they have proved that the ships and personnel are in a poor and inefficient condition, have none the less, done something towards reinstating the old Russian Navy. The Russian Government has now published what professes to be an approved building programme, which is to be completed in the next seven years. Two cruisers of 3,000 tons, four destroyers of about 1,000 tons, and eight coastal motor boats are to be built at the Putilov works for service in the Baltic; four cruisers, eight destroyers, and eight submarines, of the same type are to be built for the Black Sea; two armed gunboats of 1,000 tons are to be put into service in the White Sea; and four in the Pacific. The cruisers are to be armed with six 6-in. and four 2·9-in. guns, and the destroyers with four 4-in. guns. It is most doubtful whether the programme will be completed in the time stated; but the decision to undertake it is interesting, and the steps taken for giving effect to it will be well worth watching.

5,000,000 Cubic-Foot Passenger Airship for the British Government.

On Wednesday last, during a visit of Mr. J. H. Thomas, Colonial Secretary in the late Government, to the River Don Works of Messrs. Vickers Limited, Sir Trevor Dawson announced the fact that the firm had recently signed a contract for the construction of a rigid airship of 5,000,000 cub. ft. capacity, to the order of the British Government. The length of the hull will be 695 ft., and the maximum diameter 130 ft., the gas being contained in 11 separate bags. With the capacity mentioned, the airship will have a gross lift of 152 tons, while the disposable lift will be 75 tons. She will be propelled by seven 550-h.p. engines of a new type, using kerosene as fuel, her contract speed being 70 miles per hour. At that speed the airship will have a range of 2,500 miles, allowing for a fuel consumption 50 per cent. in excess of still-air requirements. She has been ordered by the Government to be finished as a passenger ship, and will have accommodation for 120 passengers and 12 tons of freight. When completed, in September, 1927, she will be used for experimental flights from this country to India, with one intermediate stop in Egypt. If successful, the vessel will, no doubt, be the forerunner of a high-speed regular airship service to India, with probable extensions later to Australia. Perth, it is interesting to note, would then be within eight days of London, assuming an average speed of 50 miles per hour. It may also be added that, if used for military purposes, the vessel could carry a load of 20 tons of bombs a distance of 4,200 miles at 70 miles per hour, or 6,500 miles at 50 miles per hour, and if used for scouting purposes without a load, she could cover 9,000 miles at the lower speed. The airship will be built at Howden, Yorkshire, where the company have secured two large sheds originally forming part of the Admiralty airship station there.

The Oilfields of Argentina.

After desultory prospecting in Argentina since 1885, the first important strike of oil occurred at Comodoro Rivadia, in 1907. Later, innumerable indications of oil, asphalt, rafaelite (a pitchy material like the manjac of Barbados) were found in localities from Punta Arenas, on the Straits of Magellan, right up to the extreme north of the country, over a distance of 1,500 miles; in the south near the Atlantic, and further north near the Andes. At Comodoro, in Patagonia, oil was struck at 535 m. depth, when orders for discontinuing drilling were already on the way. The Government first made the field a reserve but when part of the field was freed, over-speculation again necessitated restriction. The Fauck system was first used. Mr. Campbell Hunter, who read a very instructive paper on "The Oilfields of Argentina," before the Institution of Petroleum Technologists, last Tuesday, introduced a modified rotary system, which had given excellent results, reducing the time of drilling a well from twelve months to two months. The conditions which he described are peculiar. In the shales and clays the oil sands occur in lenses, 6 ft. thick and less, together with water and gas, the gas being quite dry. Cable drilling tools proving unsuitable, Mr. Hunter combined the Fauck beam with hollow rods through which he forced a thick mud, reversing the flush to obtain a succession of good cores; he thus avoided inadvertent drilling through oil sands into water-bearing strata. The Comodoro oilfields, which are quite close to the Atlantic shore, yielded in 1923, 527,629 tons of oils, and have altogether given 2,478,413 tons, 2,100,000 tons of which came from the Government reserve. The oil is low in light spirit, but a very good fuel oil. That is very important for Argentina, which has little coal, and the oil search was therefore pushed on during the war. Another important field was then found in the province of Neuquen, south of Mendoza. The oil there is quite different, giving 25 per cent. of petrol and 39 per cent. of kerosene. There are also rich veins of rafaelite. The occurrence of this oil field is geologically interesting, because it is in the Jurassic, which is generally little productive. The Cacheuta oilfield, further north, near Mendoza, the oldest exploited in Argentina, also gives an excellent oil, and there are thick layers of finely-laminated black shales in the district. Other important finds have been made in the Salta-Jujuy district, near the Bolivian frontier, where again a superior fuel oil, resembling the Comodoro oil, is mined. How far the oil beds extend east of the Andes is not known yet. Mr. Hunter considered the prospects of developing the oilfields of Argentina, especially at Neuquen, as very promising. At Comodoro, it was mentioned during the discussion, the average life of a well is four years, and 48 per cent. of the oil is brought up during the first year, only 8 per cent. of the total mined being produced after the first four years.

London Traffic.

The subject of London traffic has been much to the fore lately, having been dealt with during the past week both by Mr. Basil Mott, in his presidential address before the Institution of Civil Engineers, and by Mr. A. E. Bassom, in a paper read before the Institute of Transport. The same topic, it may be remembered, formed the subject of Sir Lynden Macassey's presidential address delivered before the latter body about three weeks ago. As might have been expected, Mr. Bassom's paper dealt largely with statistics relating to the growth of traffic and the delays caused by congestion. The author opened with a review of the law bearing on the subject and advanced a strong plea in favour of the unification of regulations, so that in these days, when street traffic has ceased to be of a local character, drivers shall naturally be familiar with and able to observe local regulations without special instruction, save when exceptional circumstances arise. In any step taken in this direction Mr. Bassom also suggested that existing powers might be revised and a number of anomalies removed. For instance, he pointed out that in some cases, although the unloading of coal is restricted, coke may be unloaded at any time; similarly casks of wine and beer are subject to regulation, but equally awkward and heavy crates and cases can be unloaded without restriction. Again, the police have certain powers of which they are able to make use within the 6-mile limit, but equal powers are not available to deal with congestion at many notorious points only slightly farther out. Mr. Bassom showed how traffic on all roads has increased, with a cumulative effect on that flowing to and through the towns. His statistics are too numerous to quote, and we can only recommend those interested to refer to the Institution's Journal, where they will be able to study them in detail. Figures are given to show the density of traffic at a number of points, with comparative statistics for other towns and for cities abroad. All these seem to point to London being the worst example of traffic congestion in existence, though many of the causes are felt in other places. The author gave abstracts of reports from typical towns, and it is interesting to note that, in these, tramways are more frequently cited as contributing to congestion than other causes. The indiscriminate stopping of private motor-cars in shopping districts is another. Some interesting figures are presented showing the working time lost by traffic delays at typical points in London, and put in this way it will easily be realised that a very heavy standing charge exists inimical to business, which would warrant the expenditure of considerable sums for the purpose of reducing this loss. Mr. Bassom referred to the American system of controlling traffic by holding up the flow at all crossings in one direction simultaneously over a distance of several miles. While this may be possible with equally-spaced blocks, it is difficult to see how it would work out with an irregular arrangement of streets, and would hardly appear to be applicable to our conditions. As regards remedies, it is suggested that one-way traffic would help, but that more alternative routes should be opened up; parking places off the busy streets should be provided for light and heavy vehicles; unloading and loading of packages should be expedited; certain classes of traffic should be segregated, &c. The London Traffic Act of 1924 makes it possible for the first time to regulate, to some extent, the motor omnibus traffic, and the owners of such vehicles will in future have to run their vehicles to specified schedules and in a definitely organised service. This may be expected to limit, to some extent, the running of irregular services intended only to take the cream of the traffic at particular times. These new regulations are now in force.

The Royal Institution.—The Christmas lectures this year will be delivered by Frank Balfour Browne, Lecturer in Zoology (Entomology) in the University of Cambridge, the title being "Concerning the Habits of Insects."

Specification for Electric Resistance Materials.—The British Engineering Standard Specification for Metallic Resistance Materials for Electrical Purposes No. 115, 1924, has now been issued after recent revision. Important changes have been made in the regulations relating to wire sizes. Copies of the publication may be obtained from the British Engineering Standards Association, 28, Victoria-street, London, S.W. 1, price 1*s.* 2*d.*, post free.

The Commercial Motor Users' Association.—As a direct result of the reading of a paper on "Heavy Motor Traffic," by Mr. E. S. Shrapnell-Smith, before the Royal Automobile Club, on November 5, 1903, an institution, then known as the Motor Van and Wagon Users' Association, but later as the Commercial Motor Users' Association, was founded. During the first twenty-one years of its existence, the Association has well served the interests of all concerned with the development of what is now one of the most important means of transport. The attainment of the majority of the Association was made the occasion of a banquet, which was held at the Savoy Hotel, on Wednesday evening. It was fitting that the man who inspired the formation of the Association should be its president on this interesting occasion, when he was accompanied in receiving the guests by Colonel R. E. B. Crompton, the original president. Sir William Joynson-Hicks, Bart., Sir Henry Maybury, Colonel J. Sealy Clarke, and Sir Lynden Macassey, all spoke of the valuable work done in the interests of motor transport by the Association, while Sir Arthur Stanley presented the Association with a silver cup from the Royal Automobile Club.

THE CYCLE AND MOTOR CYCLE SHOW AT OLYMPIA.

An annual exhibition of the products of manufacturers permits the accurate determination of the general outlook on design, but when the show is of an international character it also permits the comparison of British-made articles with those of foreign origin. Such an exhibition as that which was organised by the British Cycle and Motor Cycle Manufacturers' and Traders' Union, Limited, and which was opened at Olympia on Monday last, is a very good type of the annual exhibitions, which permit the gauging of the progress of industry. To Great Britain the trades concerned are of great importance, for cycles and motor cycles are articles which are exported in considerable quantities. The home trade is very largely supplied by British manufacturers, and it is very pleasing to note how the home producers are keeping ahead of all others. British cycles have an established reputation throughout the Empire and in foreign countries, and as their design and method of manufacture have for long been standardised, it may be anticipated that the position of the trade in export markets will be maintained. The motor cycle position is even more interesting. In 1922 the United States of America exported more motor cycles than the British manufacturers; to-day the position is reversed. The comparison of the figures affords great satisfaction. Whereas in 1922 the U.S.A. exported 16,000 machines, Britain only supplied 7,000 to overseas markets. The present-day position may be gauged from what was done in the first six months of this year. In that period no less than 20,000 British motor cycles were exported, while the American figure was less than half that number. Not only may satisfaction be obtained from the contemplation of the progress in exportation of British motor cycles, but the increased business done enables a cheapening of production to be effected, which ensures that either prices may be reduced or the products may be improved in important details of construction, both of which actions have the effect of increasing the demand.

An interesting feature of the Exhibition, and one bringing home to the visitor the great development in the design of motor cycles which has taken place in the comparatively few years since their introduction, is the display of historical machines. For gathering together this fascinating collection thanks are due to the Auto Cycle Union, who obtained the loan of the exhibits from builders and private owners. It may be wondered whether these machines will go back to obscurity, as far as the public is concerned, as soon as the Show closes. It is to be foreseen that some of them may eventually become the possessions of those who take but little interest in the history of engineering, and they may be broken up. Were such a thing to happen, it would be very regrettable. In commemoration of the twenty-first anniversary of the foundation of the Auto Cycle Union, negotiations might be instituted with the owners to see if they would consent to the permanent exhibition of these machines in the Science and Art Museum at South Kensington or in Birmingham, where they would be available for public inspection at any time.

In contrast with the historical use of light petrol engines, examples of light aeroplanes are also exhibited. This was made possibly by association with the Royal Aero Club and the Society of British Aeroplane Constructors. These organisations are to be commended for their foresight, for the future use of aeroplanes depends to a large extent on the manner in which flying with light machines is taken up by the type of young men to which the Motor Cycle Show makes such a great appeal. A machine made by Messrs. J. A. Prestwich and Co., of Tottenham, in 1910 is shown, with which successful flights in competitions were made by Mr. H. J. Harding that year at Blackpool. Of new machines there are two examples: the one a Beardmore Wee Bee, constructed by Messrs. William Beardmore and Co., Limited, Dalmuir, which we described in ENGINEERING recently (see page 525 current volume), and the other a Bristol Brownie all-metal aeroplane. The Beardmore machine, it will be remembered, was awarded the first prize of 2,000*l.* in the Air Ministry competitions at Lympne last month, while the Bristol aeroplane won the Duke of Sutherland's prize for landing and taking off, was second in the competition for the Air Ministry prize and also received the third prize in the competition for the Grosvenor Challenge Cup. Both machines are propelled by Bristol Cherub engines, made by the Bristol Aeroplane Company, Limited, of Filton House, Bristol.

In general, it may be stated that the design of motor cycles is fast becoming standard. Details may be changed, with beneficial effects in comfort to the rider and in the maintenance of economical use of petrol and lubricant, but fundamental construction tends to remain unaltered. Variations are to be noted between machines of different powers and for different purposes, such as touring or high-speed travel, but, on the whole, the outlook of the manufacturers is to make their designs for the specific purposes standard as soon as possible, in order that a reputation may be established. In some directions the trend of design is in the direction of protecting the component parts from effects causing heavy wear and tear and the production of excessive noise. As a vehicle of travel the motor cycle has not always received the attention of the designer which it deserves. In motor-car design every care has for long been taken to ensure that important parts are housed in such a way that mud, grit and water cannot reach them and so cause trouble, which may end in breakdown. Examples may be found, however, of unprotected motor-cycle parts, such as valve tappets exposed in such a way that easy and continued action without frequent removal for thorough cleaning is well nigh impossible. The overhead valve gears of many engines also show a lack of appreciation of the necessity for enclosure. For long, lubrication has been regarded as met by simple splash methods, and it must be owned that, in many cases, the method has proved quite effective. To-day a change of outlook is manifested in the design of some high-class machines, and automatic systems of lubrication have been introduced in some cases, while the forced-feed system is also now in use. For light machines belt drives are still common, but the advantages of chains are almost universally recognised for the larger models. It is, however, somewhat strange, when chains have been raised to such a high standard of perfection, that more is not done generally to protect them by complete enclosure. A simple guard above affords little or no protection against the intrusion of grit into the links of a chain, and its replacement by a complete casing would not entail much expense, but would be very useful in the extension of the life of the chain and in obtaining continued and satisfactory running.

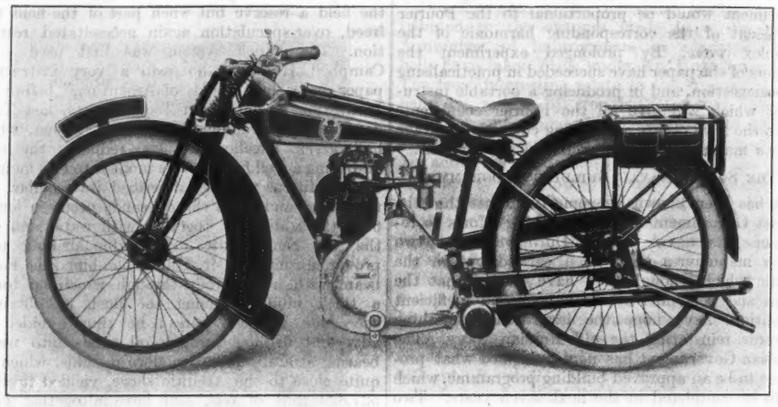


FIG. 1. 350-CC. MOTOR CYCLE WITH OVERHEAD VALVES; THE ROVER COMPANY, LIMITED, COVENTRY.

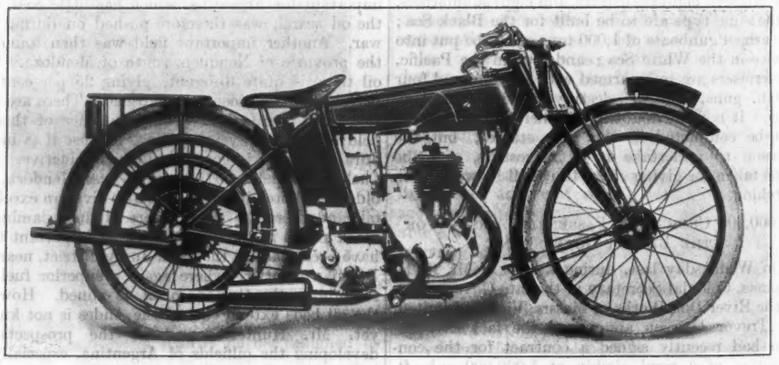


FIG. 2. 2¾-H.P. MOTOR CYCLE WITH MECHANICAL LUBRICATION; MESSRS. HUMBER, LIMITED, COVENTRY.

As an example of the 350-c.c. engined motor cycle with overhead valves, a type much in favour for high-speed running, Fig. 1 shows a machine made by the Rover Company, Limited, of Coventry. The engine of this model has a bore of 74 mm. and stroke of 80 mm. The overhead valves are situated in a detachable head, and the rocker gear to operate them is totally enclosed and has its bearings lubricated by felt pads. There is a single-cam wheel, and the valves are worked through long tappet rods extending from the crank-case. For lubrication, a submerged gear pump, such as is commonly used on car engines, is located in the bottom of the sump and draws oil through a filter. The delivery is carried under pressure through a regulator and tell-tale to the big-end bearing and the cylinder. Whatever surplus is delivered passes back into the sump. The provision of continual circulation of cool oil in this way ensures good lubrication, with the resulting advantage of improved efficiency. The transmission is effected by the use of Hans Renold roller chains, and there is a shock-absorber fitted in the rear hub. Internal-expanding brakes are provided for both wheels.

A representative cycle with an engine having

side-by-side valves is shown in Fig. 2. This is a 2¾-h.p. machine and is a product of Messrs. Humber, Limited, of Coventry. In this engine the cylinder is cast in one complete unit, the valves being introduced through openings in the head, left by the unscrewing of covers. The drive from the crankshaft to the two cams is obtained by means of gears, which are conspicuously marked, so that after dismantling, at any time, re-erection without the introduction of faulty timing is easily effected. In the model illustrated mechanical lubrication is used. For the pump, a drive is obtained from the camshaft, and the oil is delivered through a sight feed mounted on top of the tank, where it can be easily seen. On the sight feed there is a needle valve, by means of which the oil flow can be regulated to suit the requirements. The oil is delivered to a circular recess in the engine-case, from where it is supplied through grooves in the casting to the main bearings. Whatever oil goes down into the crank-case joins the lubricant there, and with it is

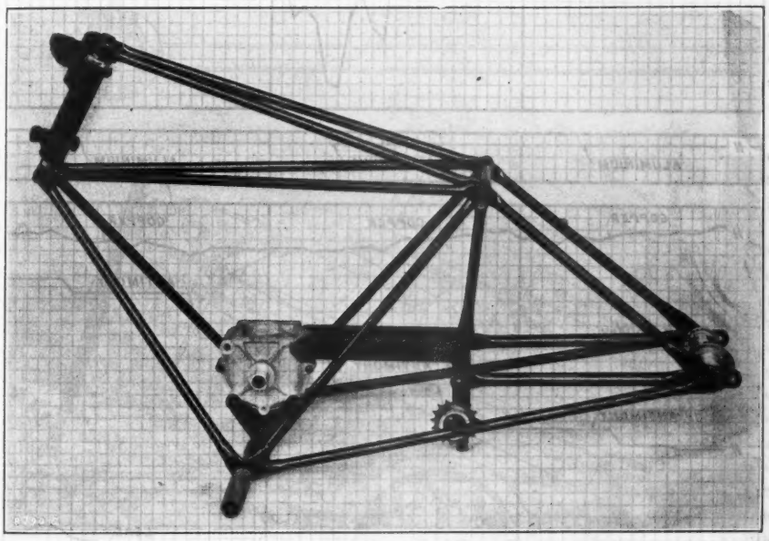


Fig. 3. Motor Cycle Frame; Francis and Barnett, Limited, Coventry.

partly splashed into the recess already spoken of, as well as to parts of the moving system. A large shock-absorber is fitted to the chain wheel on the rear hub to ensure an even drive at all speeds. In this four powerful springs take up the drive and absorb all engine shocks, preventing their transmission to the driver, while rubber pads are fitted to take up the recoil.

There is a growing tendency towards complete triangulation of the frames of motor-cycles, and a good example of this is afforded by the design of the Francis-Barnett machines. Not only, in this cycle, is the frame construction such as to ensure the combination of lightness with strength, but the manner in which the lugs are associated with the tubes is such that the weakness sometimes found in motor-cycles at these places is overcome. The lugs constitute the ends of sleeves which fit the tubes, internally or externally, and are heated with the tubes and pressed into association. By this means the lugs may be made of such dimensions that they resist the stresses, to which they are subjected, equally as well as the tubes. The design of the frame of the Francis-Barnett motor cycle, which is manufactured by Messrs. Francis and Barnett, Limited, Lower Ford-street, Coventry, is shown in Fig. 3, from which the formation of the rigid but light structure from a series of triangular panels will be appreciated. The cycles made by the firm, in which this frame is used, are small-powered machines of 1¼ h.p., 1½ h.p. and 1¾ h.p., and are propelled by the well-known two-stroke engines made by the Villiers Engineering Company, Limited, of Marston-road, Wolverhampton. They have two or three-speed gears of the Albion type, and the transmission is effected by chain and belt or entirely by chains, made by Messrs. Hans Renold, Limited, Didsbury, Manchester.

There is a strongly increasing tendency among motor cycle manufacturers to make use of standard engines, as well as other proprietory components, in the construction of their machines. From a production point of view this is a procedure to be commended because by specialisation efficient economical and reliable machines may be obtained at low cost, which makes possible an extension of trade at home and abroad. Of the standard engines, among the most commonly applied are the Villiers (see Engineering, page 683, vol. cxiv), the Blackburne, made by Messrs. Burney and Blackburne, Limited, of Atlas Works, Bookham, and the J.A.P. engines of Messrs. J. A. Prieстwich and Co., Limited, of Tottenham (see Engineering, page 506, vol. cxvi). Many makers are now installing in some of their models the Bradshaw oil-cooled engines made by Messrs. James Walmsley and Co. (Preston), Limited, a description of a two-cylinder model of which was given recently in Engineering (see page 706, vol. cxiv), while the Barr and Stroud single sleeve valve engine shows an increasing popularity (see page 44, vol. cxiii).

The application of a motor cycle to the delivery of goods by the use of a suitable side car is making good progress, and an innovation may be noted in the fitting of a small chemical fire extinguisher on a side-car chassis. This is exhibited by Messrs. Dunford and Elliott (Sheffield), Limited, of Bath-street, Birmingham. The equipment provided consists of a 25-gallon tank for chemical fire-extinguishing fluid, two 3-gallon "Sprafoam" extinguishers at the front to deal with fires caused by petrol, oil or other dangerous substances, and a rear tank with further accommodation for 3 gallons of extinguishing fluid for ordinary fires. A light collapsible ladder is also part of the equipment. The cycle is a standard machine, which has been used extensively by the makers for application to the carrying of goods.

The three-wheeler still shows some favour though the reduction of price of light cars must have meant a smaller demand. The well-known Morgan machine, which is fitted with a J.A.P., Blackburne or Anzani engine, is shown, as well as a French three-wheeler known as the D'Yrsan. In this latter machine the frame, which is very rigid, is built up of solid drawn weldless steel tubes and the suspension system consists of two semi-cantilever springs at the rear and two transverse cantilever springs, attached to the chassis at their centres, at the front. The engine, which is of the Ruby monobloc type, has four cylinders and is water-cooled on the thermo-syphon system. A small plate clutch is provided which runs entirely in oil. Three speeds and reverse are obtained through the gears which have their shafts running in ball bearings and are put into action by the movement of a ball-type lever. The transmission is effected by the use of a Cardan shaft and a Renold chain. Ferodo-lined brakes are fitted to all the wheels, those for the two front wheels being operated by a pedal and lever system, while the rear one is controlled by a hand lever.

THE LATE LIEUT.-COLONEL WALTER BROWN.

The people of Renfrew and the many who are concerned with shipbuilding on the Clyde have lost a true friend by the death, in his 64th year, of Lieut.-Colonel Walter Brown, V.D., D.L., which occurred in a Glasgow nursing home on Friday, October 31. During the whole of his business career, Colonel Brown was associated with Messrs. Wm. Simons and Co., Limited, the well-known dredger builders of Renfrew. At the age of 24 years he was promoted to the position of naval architect to the firm. He was a partner in the business prior to its reorganisation as a limited liability company in 1900, when he continued his work as managing director. Under his control in association with his brother, Mr. William Brown, the firm had made rapid progress and established a world-wide reputation for their many types and designs of dredgers.

From the days of his youth, Colonel Brown showed great enthusiasm for the volunteer movement, and he was an officer for many years of the 2nd Volunteer Battalion of the Argyll and Sutherland Highlanders. He commanded the Renfrew Company until he was gazetted Major, and he later retired with the rank of Lieut.-Colonel and received the Volunteer Decoration. Colonel Brown rendered great assistance in the raising of the Territorials, from the inception of the scheme in 1908 up to the termination of hostilities in the European War, as a member, and later vice-chairman, of the Renfrewshire Territorial Force Association. He was a Deputy-Lieutenant of the County of Renfrew. He took a great interest in educational affairs and rendered, not only as a member of the local education authority but in many other ways, great assistance in the development of educational work in the district. With his brother, Colonel Brown was a generous benefactor of Renfrew, and they both received the freedom of the burgh last year. He was elected a member of the Institution of Naval Architects in 1888, and was also a member of the Institution of Engineers and Shipbuilders in Scotland.

THE LATE MR. FULTON ROBERTSON.

The death at Musselburgh, on November 2, of Mr. Fulton Robertson removes an engineer well known for many years for his work in connection with the London tube systems. He was born in 1860. After spending two years as assistant engineer on the Whitby and Loftus and the Scarborough and Whitby Railways, he completed his course at Edinburgh University, graduating B.Sc. in 1886. This was followed by eighteen months' work as assistant to Mr. J. Sharp, M.Inst.C.E., of Hull. At this period in his career he entered the services of the San Cebrian Railway and Collieries Company, Limited, with whom he was associated until his death. During these years he was employed by the company to superintend the construction of their railway in Spain. As resident engineer he prepared plans and supervised the construction of 10 miles of metre-gauge lines, a mile of self-acting inclines, and the driving of adits for opening mines. Surveys and estimates were worked out by him for a short branch line in the Province of Seville. For the late Mr. Jacob Forrest he prepared a descriptive statement, complete with statistics, on the Avila and Salamanca Railway, data on which was required by the Railway Division in Madrid in 1894. Returning to England, Mr. Robertson became chief engineer to Messrs. Price, Wills and Reeves, contractors for the Frazerborough Harbour Works. These works included the deepening of the Balaclava Harbour, the construction of new jetties, and a breakwater involving a total sum of 60,000*l*. These works were carried out in the years 1895–96 and after their completion he became assistant engineer on the Central London Railway works in progress, under Mr. John Price, contractor for the portion of the line between Shepherds Bush and Marble Arch. This work, for which Sir Benjamin Baker and Mr. Basil Mott were the engineers, occupied his time in 1895–97. Mr. Robertson became chief engineer to Messrs. Price and Wills, contractors, on

the construction of the Rhymney branch of the Barry Railway. It may be recollected by many that this extensive contract included the laying of some seven miles of double-rail track, the making of a viaduct 1,300 ft. long over the valley of the River Taff, and the boring of a tunnel 1,500 ft. in length. The work for which Sir John Wolfe Barry was engineer, extended from 1897–1902.

Mr. Robertson then became chief engineer to Messrs. Walker Price and Reeves. While with them, he rendered valuable service in connection with the Great Northern Piccadilly and Brompton Railway, the outlay on this work reaching 1,250,000*l*. With Messrs. Price, Wills, and Reeves, he was chief engineer during their construction of the Alexandra Wet Dock and the Hughes Dry Dock at Bombay. It will be apparent that Mr. Robertson combined an extensive experience of many departments of a profession which will be the poorer for his loss.

THE LATE SIR WILLIAM C. GRAY.

Sir William Cresswell Gray, Bart., the well-known West Hartlepool shipbuilder, died at his residence, Thorp Perrow, Bedale, Yorkshire, on Saturday last. Sir William who was in his 57th year, had been in poor health for some months, but maintained a keen interest in the progress made in the construction of the firm's new shipyard and graving dock on the Tees.

He was the last surviving son of Sir William Gray, under whom he received his training. He became a director of William Gray and Co. in 1889, when it was converted into a limited liability company. On the death of his father in 1898 he succeeded to the chairmanship, and under his control the activity of the firm was greatly extended. In 1899, Sir William became the owner of the West Hartlepool Steel and Iron Works as well as the Moor Iron and Steel Works and the Stockton Malleable Works. Acting with the late Lord Furness, he merged these into one concern as the South Durham Steel and Iron Co. In addition to the activities represented by his interest in these companies, Sir William was a director of the North Eastern Railway Company and of the Pyman Steamship Company.

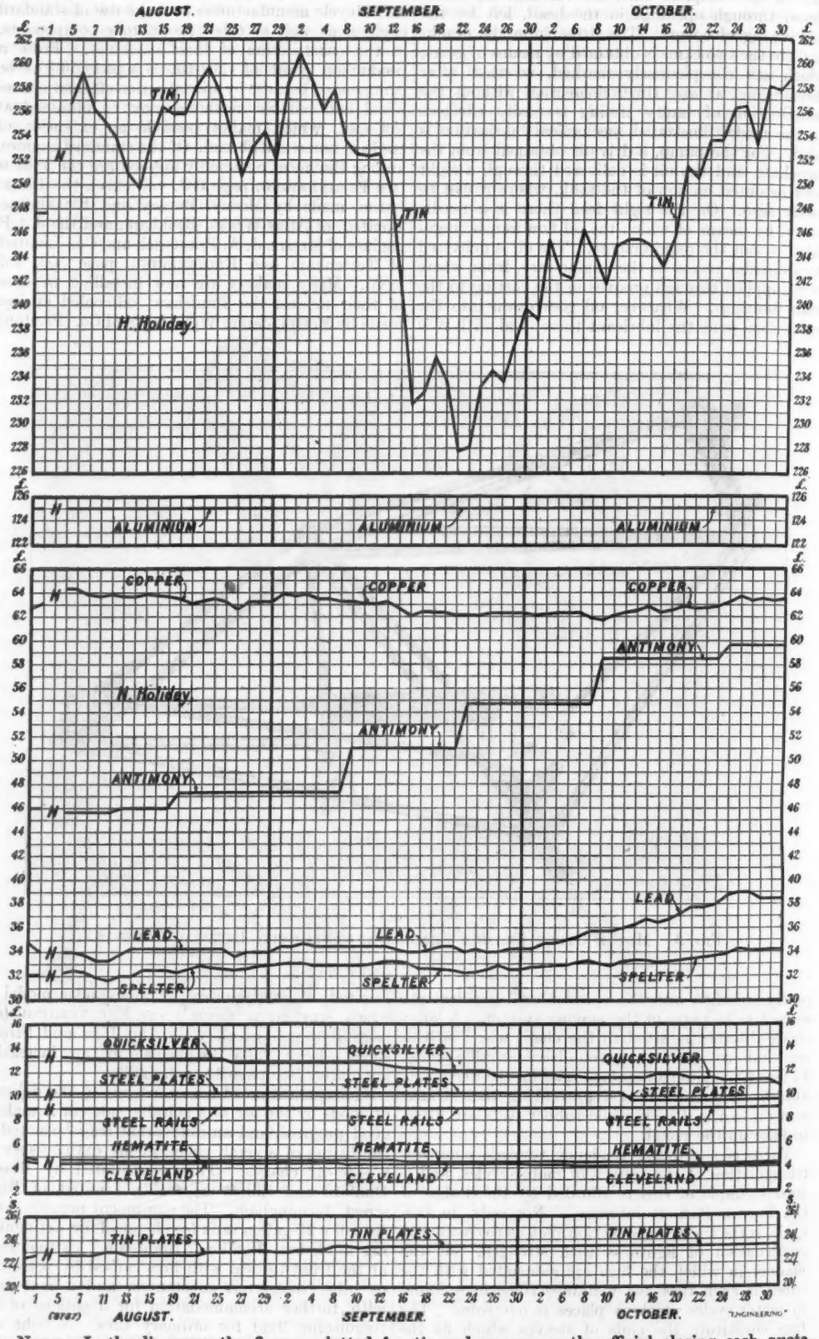
The new works of William Gray and Co., Limited, represent the last endeavours he made for progress and will remain as a memorial to his enterprise. In other ways there are many institutions in the Hartlepools which will keep him in affectionate remembrance, for he gifted sports grounds to his workpeople, created the Gray Swimming Baths at Hartlepool, and erected the Gray Convalescent Home at Seaton Carew for the benefit of the employees of his firm. He contributed generously to educational, charitable and religious institutions in the district, and presented the Gray Art Gallery and Museum to West Hartlepool. Sir William did not neglect public duties, for he served many years on the West Hartlepool Town Council, following the example of his father, who was the first Mayor. He was a Deputy Lieutenant of the County of Durham, and served for some time as High Sheriff. Sir William was one of the Hartlepools Port and Harbour Commissioners, and he was also a member of Committee of Lloyds Register.

Contracts.—The Underfeed Stoker Company, Limited, of Aldwych House, Aldwych, London, W.C.2, have recently received a repeat order from a large paper mill in Holland for six mechanical stokers.—Messrs. Fullerton Hodgart and Barclay, Limited, of Paisley, have received an order from a large firm of soap manufacturers in Germany for a patent double-effect evaporator plant for the production of glycerine from spent lyes. Prior to 1914 a similar plant was delivered and erected for the same firm in Dusseldorf; the present order is thus a repeat, but for a larger installation. The present order will make the sixth to be supplied to Germany.—Messrs. Tyer and Co., Limited, have received an order from the Buenos Aires and Pacific Railway Company for the supply of 128 key-token instruments for absolute and permissive working, and for the necessary magnetos.

Wright Brothers' Medal.—We have received from the Air Ministry an announcement of the fact that the Dayton Section of the Society of Automotive Engineers has decided to award each year a medal to commemorate the pioneer work in aviation of the Wright Brothers. The award will be made for the most meritorious contribution to aeronautical science reported to the society during the year, and designed with the object of fostering the use of aircraft of the heavier-than-air type for non-military purposes. With the exception of certain officers of the Society of Automotive Engineers, competition for the award is open to citizens of any country, and the decision will be made more in accordance with the intrinsic merit of the achievement than on the quality of the paper describing it. Papers received up to December 31 next will be eligible for the 1924 award, and such papers, with the author's name affixed, should be sent to the Wright Brothers' Medal Committee, Dayton Section, Society of Automotive Engineers, care of Engineers' Club of Dayton, Dayton, Ohio.

DIAGRAMS OF THREE MONTHS' FLUCTUATIONS IN THE PRICES OF METALS.

(Specially Compiled from Official Reports of London Metal Markets.)

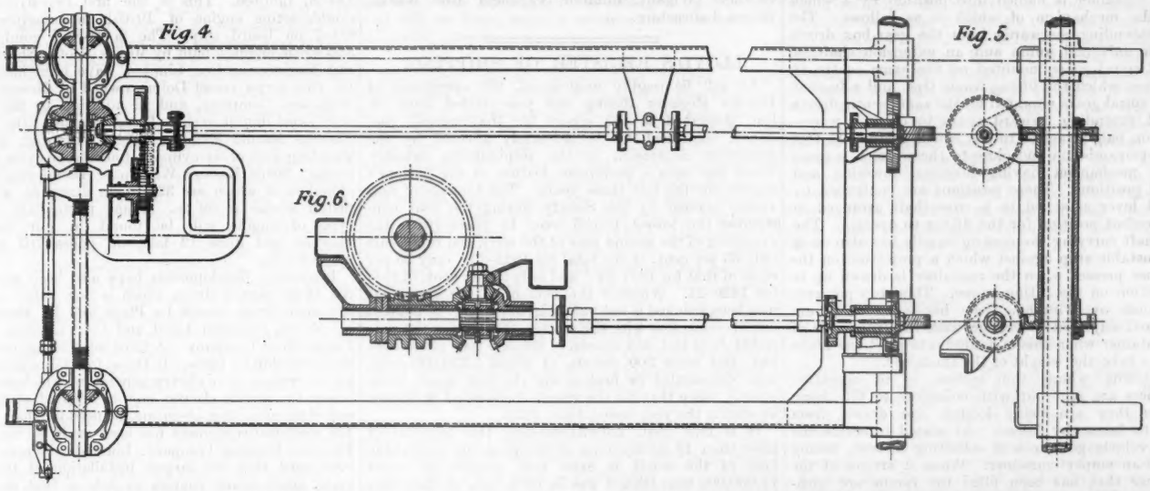


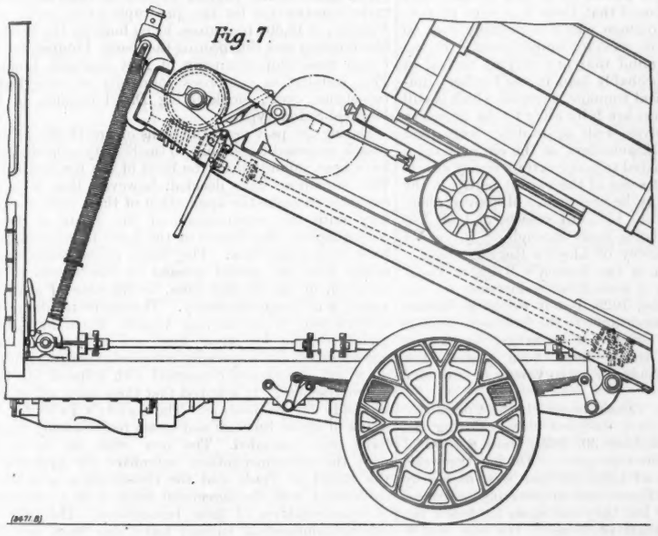
Note.—In the diagrams the figures plotted for tin and copper are the official closing cash quotations of the London Metal Exchange for fine "foreign" and "standard" metal respectively. The prices shown for lead are for English metal, whilst those for spelter are for American metal. Middlesbrough prices are plotted for steel plates and rails, and also for hematite and Cleveland pig-iron. The prices given, in the case of steel plates are for ship, bridge and tank qualities, and those for steel rails are for heavy sections. The pig-iron prices are for East Coast hematite and Cleveland iron, both of No. 1 quality and for home consumption. The price of quicksilver is per bottle, the contents of which vary from 70 lbs. to 80 lbs. The price of tin-plates is per box of I.C. cokes f.o.b. at Welsh ports, but in other cases the prices are per ton. Each vertical line in the diagram represents a market-day, and the horizontal lines represent 1*l*. each, except in the case of the diagram relating to tin-plates, where they represent 1*s*. each.

The Late Mr. C. O. Bastian.—A pioneer in the development of electric heating, Mr. Charles Orme Bastian, died in his 55th year, on October 29. He was the eldest son of Dr. Charlton Bastian, F.R.S., and was educated at University College. His practical training was obtained in the works of Messrs. Crompton and Co., Limited. Many improvements in electrical plant, especially in appliances connected with the use of radiant heat, owe their origin to his inventive abilities. Mr. Bastian was the inventor of the water heater and thermal storage geyser both of which bear his name.

THE PAGEFIELD SYSTEM OF REFUSE COLLECTION.

MESSRS. WALKER BROTHERS (WIGAN), LIMITED, ENGINEERS, WIGAN, LANCS.





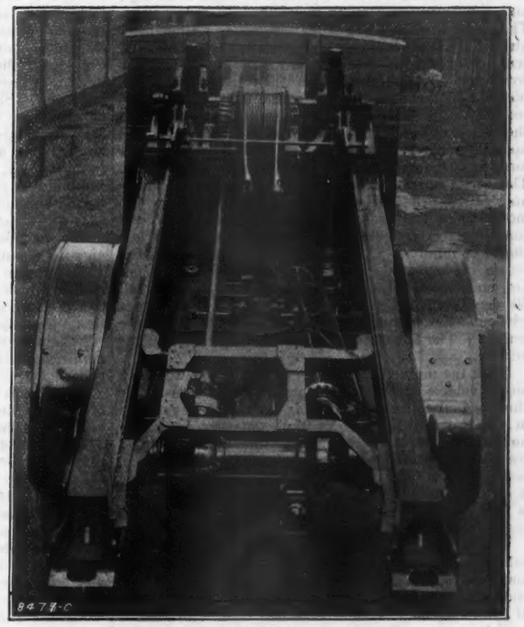


FIG. 8. VIEW OF CHASSIS.

THE PAGEFIELD SYSTEM OF REFUSE COLLECTION.

THE Pagefield system of refuse collection, the vehicles for which are illustrated in Figs. 1 to 8, on page 646 and above, has as its essential feature the combined use of horse and motor transport. It has long been realised that when an expensive motor vehicle is used for slow detail delivery or collection it is not being employed to the best advantage, and the Pagefield system has been evolved to permit the motor vehicle to do the long trips from point to point, and to provide a means by which horses can be employed for the slow house to house delivery or collection. Although this system is finding other applications it was primarily designed for refuse collection, and the description which follows is confined to this work, although from the method of working it will be readily seen how it can be used for other purposes.

For the actual collection of refuse, low-sided containers mounted on small wheels are provided. One of the great features aimed at has been to keep the containers as low as possible for ease of loading. The maximum height of the sides is 4 ft. 6 in., although the greater part of the load can be put in at a height of 3 ft. 7 in. by lowering the top portion of the sides which are formed as hinged doors. The size of the road wheels was a matter for serious consideration, as it was necessary to keep the containers as low as possible, and at the same time not to make the wheels so small as to put undue load upon the horse. The 21 in. wheels with special bushes fitted as standard have proved to be a very satisfactory compromise, and the ordinary draught-horse has no difficulty in moving the container from house to house even when loaded with its full 3 tons of refuse. The containers are fitted with strong canvas covers on the top (as will be seen in Fig. 2) and the whole of the rear end is formed by two doors hinged at the sides to permit of a free passage of the refuse when it is being tipped at the place of disposal.

The motor vehicle used in connection with the system, which is illustrated in Figs. 1, 2 and 3, has as its main units, *i.e.*, engine, gear-box and rear axle, the parts used in the standard 4 ton to 5 ton Pagefield lorries, but the frame, springs and other parts have been designed specially in view of the peculiar stresses imposed by the method of loading and by the tipping of the load. The chassis is provided with a tipping frame hinged at the rear end and arranged so that the front end can be lifted by means of the "Pagefield" patent mechanically operated tipping gear. The main members of this lifting frame are box-section girders of pressed steel, and these serve as receptacles for two ramps, which, when withdrawn form a pathway from the ground, along which the container can be drawn on to the motor lorry. These ramps are held both in the in and out positions by automatic catches. At the front end of the lifting frame is fitted a winch drum having two steel wire ropes for hauling up the containers or lowering them to the ground. Both tipping gear and winch are driven by gearing from the engine of the lorry. The gear-box of the lorry has fitted to it a special lid containing wheels which can be put into gear with the constantly running gears of the gear-box. From this special lid a shaft projects forward to drive the tipping gear, backward to drive the winch.

The mechanism of the tipping gear will be understood from Figs. 4 to 8, annexed. On the end of the shaft projecting forward from the gearbox a bevel pinion is fitted which meshes with two bevel wheels running loose on a shaft extending across the chassis frame. This cross shaft carries at its outer ends bevel wheels driving vertical telescopic screws of large diameter. On the cross shaft situated between the two loose bevel wheels is a dog clutch which can be thrown into engagement by a hand lever with one or other bevel wheel for raising or lowering the lifting frame. The cross shaft is also threaded and carries a nut of phosphor bronze. This travelling nut is so arranged that it comes into contact with stops on the gear striking rod at top and bottom of the lift and the mechanism is automatically thrown into neutral so that the gear cannot over-run at the top, nor can the lifting frame be pulled down on to the chassis in such a manner as to do damage. This tipping gear is thus automatically controlled and is entirely foolproof.

There are two definite angles of tip to which the lifting frame must be raised. The first angle is about 25 deg., and is so arranged that when the ramps are extended the rear ends are on the ground. The second angle of tip is 50 deg. and is used for emptying the load. The automatic safety gear of the tipping mechanism comes first into operation at the lower angle of tip so that the driver or attendant cannot negligently run up to the full angle of the tip with the ramps extended.

In order to lift to the full angle of tip the first stop must be held out of engagement by the driver until the 25 deg. angle of tip is passed, when the mechanism is thrown out at the full angle of 50 deg.

The container is hauled into position by a winch gear, the mechanism of which is as follows: The shaft extending rearwards from the gear-box drives through universal joints and an extension shaft, a pair of spiral gears mounted on the same centre as that upon which the lifting frame tips, and a further pair of spiral gears mounted on the same centre drives a shaft extending forward again to drive a worm-reduction pair attached to the winch barrel. In this line of transmission and close to the worm is a gear-change mechanism having hoisting, lowering and neutral positions. These positions are controlled by a hand lever attached to a cross-shaft arranged in a convenient position for the driver to operate. The cross-shaft carrying the control handle has also on it an adjustable stop against which a projection on the container presses when the container is drawn up to its position on the lifting frame. This stop prevents the winch overwinding. Two hooks or claws are fitted and adjusted to engage with the front axle of the container when this is hauled into position. These serve to take the weight of the container.

In towns where the system is in operation containers are sent out with collectors to fill them, and as they are being loaded, are drawn from house to house by horses. At stated intervals the motor vehicle goes into a collecting district, taking with it an empty container. When it arrives at the container that has been filled the ramps are withdrawn, the lifting frame is tipped to an angle of 25 deg., and the empty container is lowered to the ground. The horse is withdrawn from the full container by a quick detaching device, which permits the horse being transferred with its harness and shafts to the empty container. The motor wagon then manœuvres into position in front of the full container. The haulage ropes are attached and the full container raised on to the lifting frame. The lifting frame is returned to the horizontal, the ramps are pushed home, and the motor lorry is then ready with its load to proceed to the tip. The whole operation of lowering the empty container and raising the full container, from the time the motor lorry arrives at the collecting district to the time it is ready to start on its trip to the tip, is less than five minutes. At the tip or destructor, where the refuse is deposited, the rear doors of the container are opened, the lifting frame is raised to the full 50 deg., and the whole of the refuse is shot out without the container being removed from the wagon. The time required for tipping is about one minute.

From the method of working it will be seen that one motor vehicle is sufficient to provide the transport for three or four collecting districts. As an actual example in one town the filling of the container from the household bins takes two hours. The time occupied by the motor wagon in making the complete trip, picking up a full container in one district, emptying it at the destructor, and taking it into another district is half an hour, so that in this case by having five containers four collecting districts are served.

Where single mechanical units are used for refuse collection their mileage cost when used for slow house-to-house work is extremely high. There is also another very great consideration acting in favour of the Pagefield system. When the unit motor vehicles are on their journey to and from the tip, the bin men or collectors have no receptacle into which they can empty the refuse and consequently lose this time, and are, for all practical purposes, unemployed. In the Pagefield system, however, the empty container is deposited with the men before the full container is taken away, consequently the whole time of the collectors can be efficiently employed. The low-sided containers have proved a very great advance in many respects over the old type high-sided horse-drawn wagons. Not only can they be filled more quickly on account of their decreased height, but the filling is also more hygienic, as there is not the same tendency for dust to be blown about. A further great advantage is that the low containers do not impose upon the men the very serious strains they experience in using the high-sided horse-drawn vehicles.

The Pagefield system was first installed at Southport, where a set comprising one motor vehicle and five containers went into operation some three years ago. After this had been at work some time and had shown a saving of 20 per cent. over the original method of collection, two further sets were ordered. One of the motor vehicles is not occupied the whole of its time as a refuse collection vehicle, and carries in addition to the tipping frame and winch, an ordinary type lorry body so that it can be used for the conveyance of road materials, or applied to general haulage. In the borough of Wandsworth seven motor wagons and about 30 containers collect the refuse from a population of over 350,000. In Derby one set has been at work nearly twelve months, and a further set has been ordered, and in Worthing this system has also been at work for some twelve months.

The vehicles are manufactured by Messrs. Walker Brothers (Wigan), Limited, Pagefield Iron Works, Wigan, Lancashire.

LLOYD'S REGISTER OF SHIPPING.

As will be readily understood, the operations of Lloyd's Register during the year ended June 30 last, described in the report for that period, just issued, continued to be adversely affected by the persistent depression in the shipbuilding industry which has been a prominent feature of the Society's reports for the last three years. The tonnage of new vessels classed by the Society during the year constitutes the lowest record over 15 years (with the exception of the second year of the war), and represents only 55 per cent. of the total for 1922–23; only 35 per cent. of that for 1921–22; and only 27 per cent. of that for 1920–21. Whether the bottom of the curve has now been reached is not yet clear, but it may be pointed out in connection with the matter, that during the year ended June last, 454 vessels, of 600,595 tons gross, were lost, and some 500 vessels, of about 1,250,000 tons, were dismantled or broken up, the last figure being exactly twice that for the vessels dismantled or broken up during the year ended June, 1923.

It is true that, notwithstanding this removal of more than 1¾ million tons of shipping, the mercantile fleet of the world is even now greater by about 15,000,000 tons than it was in 1914, but, on the other hand, it is well recognised that there is a large proportion of the laid-up tonnage which is unlikely ever to be able successfully to seek for employment. It has also to be borne in mind that any serious revival in overseas traffic will probably lead to the further elimination of uneconomical tonnage, some of which is still in service. Shipowners are fully alive to the necessity of providing themselves with up-to-date fleets, and they are aware that shipbuilders, in the circumstances now existing, are prepared to make extraordinary efforts to meet them, so that some of the vacant berths in the shipbuilding yards may be occupied. Moreover, there were, at the end of June last, 461 vessels, of 1,641,246 tons gross, actually being built throughout the world under the Special Survey of Lloyd's Register, with a view to classification in the Society's Register Book. This tonnage shows a considerable increase on the similar figure for June, 1923, but it would be unwise to attach too much importance to the fact, as it appears that, while several orders for passenger liners and vessels for special trades have been placed, few inquiries are being made for cargo vessels of ordinary types.

The figures of new vessels to which the Committee of Lloyd's Register have assigned classes during the twelve months ended June 30, 1924, show a total of 371 vessels of 885,660 tons gross. During the year, plans for 489 vessels, of 1,308,845 tons, were passed by the Society. These figures are appreciably in excess of those for 1922–23, but they are again far below the average for several years previous to the war, and it does not necessarily follow that all the proposed ships will actually be built.

Of the vessels built during the year which have received the Society's Classification, eight are of 10,000 gross tons and upwards, the three largest being the Duilio, of 23,228 gross tons for the Navigazione Generale Italiana, the Mooltan, of 20,847 tons for the Peninsular and Oriental Steam Navigation Company, and the Maloja, of 20,837 tons, for the same owners. Steam turbines were fitted in 11 new vessels, making 99,464 gross tons together, four of which exceeded 10,000 tons each. Except in the case of the Duilio, the turbines were used in conjunction with reduction gearing, generally of the single-reduction type. During the year, 45 vessels, making 242,162 tons in the aggregate (or 27·3 per cent. of the total tonnage of new vessels classed) were fitted for burning oil fuel for steam raising.

Vessels fitted with oil engines to which classes have been assigned by the Society during the year, numbered 62, and had an aggregate gross tonnage of 163,795. Twelve of the number exceeded 5,000 gross tons each. The period covered by the report is noteworthy for the introduction into actual service of double-acting Diesel engines, and the great increase in the number of such engines under construction. With these developments the Society has been very closely concerned, and, as evidence of the progress being made in this direction, reference may be made to some examples of various types of these engines which are being built under the superintendence of their surveyors. Of these, the construction of the two six-cylinder, four-stroke cycle, double-acting Diesel engines being made by Messrs. Burmeister and Wain, of Copenhagen, for a twin-screw passenger vessel, by Messrs. Sir W. G. Armstrong, Whitworth and Co., Limited, for the Swedish-American Line, has been further advanced. The three-cylinder, two-stroke cycle, double-acting Diesel engine, built by the North-British Diesel Engine Works (1922), Limited, has been installed in the single-screw vessel Swanley, owned by Messrs. Harris and Dixon, Limited. This is the first two-stroke cycle, double-acting engine of British manufacture to be fitted on board ship. The Scott-Still combined oil and steam engines, built by Messrs. Scott's Shipbuilding and Engineering Co., Limited, have been installed in the twin-screw vessel Dolius, owned by Messrs. Alfred Holt and Company, and in addition to the above-mentioned double-acting Diesel engines, the North Eastern Marine Engineering Co., Limited, are constructing a set of six-cylinder, four-stroke cycle, double-acting, North Eastern-Werkspoor Diesel engines, the cylinders of which are 32½ in. in diameter, while the piston stroke is 59 in. Some particulars of this type of engine will be found in our issues of May 30 and June 13 last, on pages 707 and 771 respectively.

Interesting developments have also been made with the Diesel-electric drive, which is now fitted on board the single-screw vessels La Playa and La Marea, built by Messrs. Cammell Laird and Co., Limited, for the United Fruit Company. A third set is being installed in the sister-ship La Perla. In these, four Camellaird-Fullagar oil engines drive electric generators, which supply the power to operate electric motors situated at the after end of the ship, thus obviating the need for shaft tunnels. The electrical equipment has been made by the British Thomson-Houston Company, Limited. It may also be mentioned that the largest installation of two-stroke cycle, single-acting engines to date is that at present under construction for the quadruple-screw motor ship Aorangi, of 18,500 tons gross, being built by the Fairfield Shipbuilding and Engineering Company, Limited, for the Union Steamship Company of New Zealand, Limited. This installation comprises four sets of six-cylinder, two-stroke cycle, single-acting Diesel engines, of the Fairfield-Sulzer type.

During the past year, the plans of practically all new vessels proposed to be built to the Society's classification have been submitted on the basis of the Revised Rules. The committee have decided, however, that it is not desirable to make the application of these rules compulsory until the requirements of the Board of Trade, consequent on the Report of the Load Line Committee, have been made clear. They have, nevertheless, determined that the special consent of the owners to the adoption of the revised rules, in the case of any new vessel, is no longer necessary. The requirements for the construction of oil-carrying vessels, which have been under revision for some time, are at present under consideration by a specially constituted sub-committee, on which all interests concerned with ships of this type are represented. It is hoped that these rules will shortly be ready for publication. The Society's Rules for the shafts of steam turbines and steam reciprocating engines have been amended. The new rules are in accord with the recommendations submitted for approval to the Board of Trade and the classification societies in conformity with the agreement reached by a conference of representatives of those Institutions. The rules for internal-combustion engines have also been amended as regards the sizes of shafting and the scantlings of dished ends of air receivers. The requirements concerning the periodical surveys of all types of internal combustion engines have been revised. The principal alteration is that, instead of requiring an annual survey of engines of these types, a complete survey is to be made upon the occasion of a vessel undergoing the special periodical surveys, and at each intervening period of two years a modified survey of the machinery is to be held.

The report also deals with the Society's work in connection with both marine and land refrigerating plant, mentioning that proprietors of refrigerated stores have continued to avail themselves of the Society's experience, both in the design and construction of new stores and for extensions to existing buildings. In connection with the increasing use of wireless direction-finding apparatus for navigation purposes, the report states that vessels so equipped will in future be distinguished in the Register Book by the notation of "Wireless D.F." printed against their names. The society's activities in connection with the testing of materials are referred to in the report, as also are the Lloyd's Register scholarships and the various changes that have occurred in the staff during the year. We notice that 23 scholarships in naval architecture and marine engineering, each tenable for three years, are now maintained by the committee; 20 of these are specially assigned to the Universities of Glasgow, Durham, Liverpool, Tokio and Michigan, and to the Massachusetts School of Technology, while the remaining three are awarded through the Institute of Marine Engineers and may be held at any approved university or other centre of advanced technical education. Full particulars of these scholarships may be obtained from the Registrars or secretaries of the Universities or Institution mentioned.

NOTES ON NEW BOOKS.

TEXT-BOOKS are produced by three classes of writers: those who possess nothing more than the technical training that is afforded by a school; those who have combined with that some superficial acquaintance with shop practice; and others who are first and always craftsmen, aided by an intelligent study of the technical basis of their craft, gathered in a school or by laborious self-tuition. These are the men who write the books which are most useful to the apprentice and student, since they alone are able to discriminate the great essentials from matters that have little or no bearing on workshop practice. A volume of this character is "*Pattern-making*," by Mr. John McC. Wilson (Constable and Co., Limited, price 3*s.* 6*d.*). The author disclaims any attempt to treat of advanced subjects, but confines himself to those which a pattern-maker should require during the first five years of his training. And, with the aid of 100 well-selected illustrations, he has produced a valuable little treatise. In consequence of the immense variety that characterises the trade, and the fact that it is inseparably linked with the craft of the moulder, it is one that is not easily taught satisfactorily. Seldom, indeed, will two men, working in different shops, scheme and construct patterns, save those of a very simple character, in the same fashion. Often there are alternatives to be considered, some of which may be of equal utility, but more often one is preferable to others. The call for the exercise of intelligent judgment is always insistent. To those who take their work seriously, and aim at a high standard of excellence, this trade offers more attractions than some others in which the practice is more uniform, and the methods more cut-and-dried, degenerating into rule-of-thumb. In this manual the writer gives a brief account of timber and its behaviour, of the tools and their uses, of the elementary constructions that concern all classes of patterns and core boxes. Following this are selected examples of patterns of typical kinds—gear wheels, chilled work, ornamental columns, cylindrical work generally, skeleton patterns, swept-up work, and much beside, all very concise, but embracing a variety of subjects within the space of 140 pages.

We briefly notice two new books on hydraulics. The "Lehrbuch der Hydraulik," by Dr. Ing. Theodor Pöschl, of Prague, is written for engineers and physicists and is adapted chiefly to the needs of students. Some practical hints are given, *e.g.*, on lubrication, and a few problems are worked out, *e.g.*, on the load which a balloon can carry in different seasons. But the treatment is essentially mathematical, and the problems dealt with are mainly those of unidimensional hydraulics. The theory of waves, the circulation of the subsoil water, and the problems of hydraulic construction are not discussed. The science of hydraulics is in a transition stage. The practice of flying has supplied us with data on aerodynamics as yet too complex to fit into a concise general theory, and the student of twenty years hence may find the subject less difficult; the way in which the apparent confusion of the early views on radioactive phenomena and on many kinds of radiations has been cleared up justifies some hope. The other book, by Dr. Tech. Ludwig Mühlhofer on "*Zeichnrische Bestimmung der Spiegelbewegungen in Wasserschlössern von Wasserkraftanlagen mit unter Druck durchflossenem Zulaufgerinne*" is a monograph on the graphic predetermination of the level fluctuations in the forebays of hydraulic plants fed by conduits under pressure. The author, who is engineer to the firm of Innerebner und Mayer, vorm J. Riehl, of Innsbruck-Wien, has found that these complex problems can more simply be solved, in general, by graphic methods than by analysis, and he exemplifies his method by reference to several installations. Both the volumes are published by the firm of Julius Springer, Berlin, the price of the first book being 2 dollars, and that of the second book 0·95 dollar.

When the cost of books is often so high as to make those in search of knowledge hesitate before indulging in additions to their library, it is refreshing to find a volume of 400 pages of good material to be had for 5*s.* net. "*Locomotive Management from Cleaning to Driving*," by Messrs. J. T. Hodgson and J. Williams (*The Railway Engineer*, London), in its fifth edition, will, we feel sure, continue to serve the excellent purpose for which it was introduced, and as pointed out, its price is so reasonable as to be within the means of any of those practically connected with the subject of which it treats. It is an excellent book for drivers, firemen and cleaners, inspectors and others, full of practical information on subjects on which such men must have considerable knowledge nowadays if their duties are to be intelligently performed. The drawings as a rule are excellent, but the half-tone engravings are not quite up to the same level. We are not altogether in sympathy with the dotting of pictures of locomotives about the volume in a rather promiscuous way, but this does not greatly affect the value of the work. The descriptive part of the work is supplemented by chapters giving examination questions on various parts of the subject. The book has been brought up to date and will, we hope, enjoy a continuance of its hitherto successful career.

The young man who contemplates striking out for himself and going abroad is often at a loss to know how best to proceed in the acquisition of some knowledge of the country to which he feels attracted. In these days of organised emigration to our Dominions and Colonies, the matter is not quite so difficult as it used to be in their particular connection, but there still remain large areas in the Tropics which we as a people are accustomed to man with traders, engineers, officials and others, and about which information is not easily acquired. However lightly "book learning" may be valued by the old stager who has acquired his information in the school of long experience, to any novice with sufficient common sense to use a little discrimination, some preliminary advice, even when acquired through books, may prove extremely valuable. As a term of service in the Tropics is frequently one of several years, mistakes as regards equipment, &c., are not always easy to remedy, while some acquaintance with the customs of a country will, if properly used, help in avoiding difficulties which might result in unpleasant developments. A little book before us at the moment is of the type likely to be of help under these circumstances. "*Coast and Bush Life in West Africa*," by "Coaster" (Gay and Hancock, Limited, London; price 2*s.* 6*d.* net) is a chatty little work containing advice mingled with anecdote in a manner which deprives it of all tedium. The short time occupied in its perusal will amply be repaid to the potential "coaster's" to whom it is addressed, and by many other young fellows, who may have been attracted by the enticing displays made at Wembley, to assist in the development of our overseas possessions in the Tropics. Though anecdotes are sometimes a little long drawn out, the morals they point are sound and the book is full of useful tips regarding life, kit, relations with labour, &c. All primarily relate to the "West Coast" trader, but much in the book is sound advice applicable to a much larger sphere.

In our issue for June 11, 1920, we gave a detailed review of the work by Professor Ewing, on "*Thermodynamics for Engineers*." This work has greatly appealed to French scientists and professors, and a translation in French, by Mr. M. R. Duchêne, has now been issued under the title "*Thermodynamique*." According to the translator, the courses in thermodynamics given in the French technical colleges allow of solving a certain number of highly-theoretical problems, the procedure being generally comparable to exercises in mathematical analysis. Somewhat serious difficulties are experienced when, with the aid of these same courses, it is desired to deal with questions of a practical nature, and in such circumstances it is necessary, as a rule, to have recourse to guide-books or to treatises on industrial physics which give ready-made formulae coupled with numerical values. The finding of a formula starting from first principles, has often been aspired after, were it only to ascertain that it is applicable in the instance under consideration. The work by Professor Ewing is found to meet the case, and the method he has followed is acknowledged to be a particularly appropriate one. The French book is a complete translation of the work in question, and is published at the price of 50 francs by Messrs. Gauthier-Villars and Co., Paris. The same publishers have also now issued the fourth edition of "*Thermodynamique a l'usage des Ingénieurs*, by the well-known French scientist, M. Aimé Witz, a work which is intended by the author to serve as an introduction to the study of heat-engines. It opens with an exposition of the general principles of thermodynamics, followed by considerations on the Carnot cycle, the study of gases, solids, liquids and steam, the flow of gases, and steam, études on the cycles and their efficiency. Compared with the former editions, the present one will be found to enter in greater detail into the study of entropy and other diagrams. The price of this fourth edition of the work by Mr. Witz is 20 francs.

It is manifestly to the advantage of an industrial community that fluctuations in the volume of employment should be reduced to the minimum. Booms and slumps in trade are both causes of economic loss, and although the causes of the main waves of activity and depression are still too obscure for regulation, the seasonal fluctuations of particular industries are possibly more amenable to remedial efforts. All the trades connected with building have their active and dull periods every year, and an investigation has been conducted in the United States with a view to determining to what extent the unemployment consequent upon seasonal conditions could be mitigated. The question is discussed in "*Seasonal Operation in the Construction Industries—the Facts and Remedies*," which embodies the report and recommendations of a committee of the President's Conference on Unemployment, and is published in London by the McGraw-Hill Book Company, Inc., at 10*s.* 6*d.* net. The remedies suggested, as might be expected, are mostly concerned with the exercise of foresight in planning work, and the use of all apparatus and appliances to make work possible under adverse weather conditions. The circumstances in America are so vastly different from those obtaining here that English readers will find little which is applicable in detail to our own building industry, but if the book stimulates efforts in this country to keep building operations going more continuously throughout the year its effect will be entirely beneficial.

BOOKS RECEIVED.

Die zietgemasse Heissdampflokomotive. By Dr. Ing. e.h. ROBERT GARBE. Berlin: Julius Springer. [Price 3·35 dols.]

Industrial Conflict. The Way Out. A Study of the Industrial Problem in its Practical Aspects. By the Rt. Hon. GEORGE N. BARNES. London: Sir Isaac Pitman and Sons, Limited. [Price 3*s.* 6*d.* net.]

Canada. Department of the Interior. Dominion Water Power Branch. Water Resources Paper No. 40. *Surface Water Supply of Canada. Arctic and Western Hudson Bay Drainage (and Mississippi Drainage in Canada) in Alberta, Saskatchewan, Manitoba and Western Canada*, 1921–22. Ottawa: Director of Water Power.

Uber die Festigkeit elektrisch Geschweisster Hohlkörper. By E. Höhn. Berlin: Julius Springer.

Resistance des récipients Soudés a l'électricité. By E. HŒHN. Leige and Paris: Ch. Berauger.

Das Kalkbrennen. By BERTHOLD BLOCK. Second edition. Leipzig: Otto Spamer. [Price 25 gold marks.]

United States Bureau of Labour Statistics. Bulletin No. 353. *Wages and Hours of Labour in the Iron and Steel Industry*, 1907 to 1922. [Price 20 cents.] No. 354. *Union Scale of Wages and Hours of Labour, May 15*, 1923. [Price 20 cents.] Washington: Government Printing Office.

The Principles of Applied Electrochemistry. By A. J. ALLMAND, M.C., D.Sc., F.I.C., and J. T. ELLINGHAM, A.R.C.S., B.Sc., Second edition, revised and enlarged. London: Edward Arnold and Co. [Price 35*s.* net.]

Handbuch der Ingenierwissenschaften Part III. *Der Wasserbau.* Chapter 7.—*Landwirtschaftlicher Wasserbau, Fischereilicher Wasserbau. Dünenbau und Seedeiche.* Edited by the late PAUL GERHARDT. Fifth edition. Leipzig: Wilhelm Englemann. [Price 34 *gold marks.*]

The Civil Engineers' Cost Book. By Colonel T. E. COLEMAN. Fourth edition. London: E. and F. N. Spon, Limited. [Price 10*s.* 6*d.* net.]

United States Bureau of Mines. Technical Paper No. 358. *Production of Explosives in the United States during the calendar year 1923. With Notes on Mine Accidents due to Explosions.* By W. W. ADAMS. [Price 5 cents.] No. 364. *Permissible Explosives, Mining Equipment and Apparatus Approved prior to January 1, 1924.* By J. E. CRAWSHAW and others. [Price 5 cents.] Washington: Government Printing Office.

Lewis Institute. Structural Materials Research Laboratory. Bulletin No. 12. *Tests of Impure Waters for Mixing Concrete.* By DUFF A. ADAMS. Chicago: Structural Materials Research Laboratory.

Handbook on Ball and Roller Bearings. By A. W. MACAULAY. London: Sir Isaac Pitman and Sons, Limited. [Price 12*s.* 6*d.* net.]

Thermodynamique a L'Usage des Ingenieurs. By AIMÉ WITZ. Paris: Gauthier-Villars and Cie. [Price 20 francs.]

Distillation du Bois. By G. DUPONT. Paris: Gauthier Villars et Cie. [Price 25 francs.]

Platelayers' Guide with Tables and Diagrams of Switches and Crossings. Sixth edition. Darlington: Thomas Summerson and Sons, Limited. [Price 7*s.* 6*d.*]

Untersuchengen zur Klärung der Frage der elektrischen Verhüttung schweizerischer Eisenerze. By R. DURRER. Dusseldorf: Verlag Stahleisen, m.b.H.

The Life of John William Strutt, Third Baron Rayleigh, O.M. By his son, ROBERT JOHN STRUTT, Fourth Baron Raleigh, F.R.S. London: Edward Arnold and Co. [Price 25*s.* net.]

The Enlarged Callendar Steam Tables (Fahrenheit Units). By PROFESSOR H. L. CALLENDAR, F.R.S. London: Edward Arnold and Co. [Price 7*s.* 6*d.* net.]

The Mollier Diagram for Saturated and Superheated Steam. Plotted by PROFESSOR H. L. CALLENDAR, F.R.S. London: Edward Arnold and Co. [Price 1*s.* net.]

The Corrosion of Metals. By ULICK R. EVANS, M.A. London: Edward Arnold and Co. [Price 14*s.* net.]

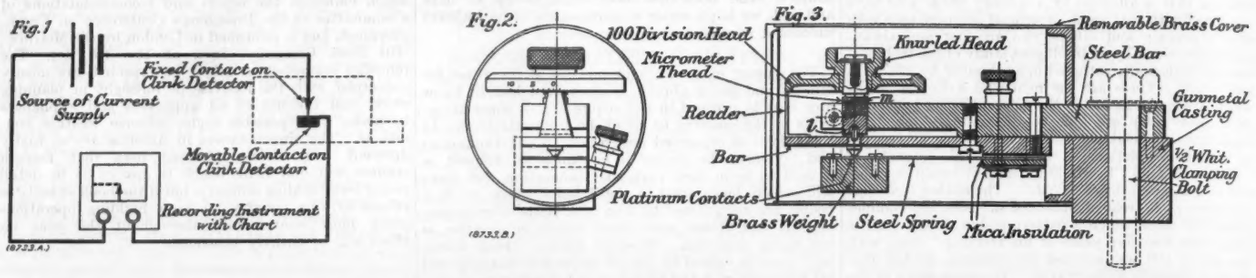
The Measurement of Fluid Velocity and Pressure. By J. R. PANNELL. Edited by R. A. FRAZER, B.A., B.Sc. London: Edward Arnold and Co. [Price 10*s.* 6*d.* net.]

Applied Elasticity. By JOHN PRESCOTT, M.A., D.Sc. London: Longmans Green and Co. [Price 25*s.* net.]

Wireless Valve Transmitters. The Design and Operation of Small Power Apparatus. By W. JAMES. London: The Wireless Press, Limited. [Price 9*s.* net.]

CLINK DETECTOR FOR STEEL INGOTS AND FORGINGS.

THE CAMBRIDGE INSTRUMENT COMPANY, LIMITED, ENGINEERS, LONDON.



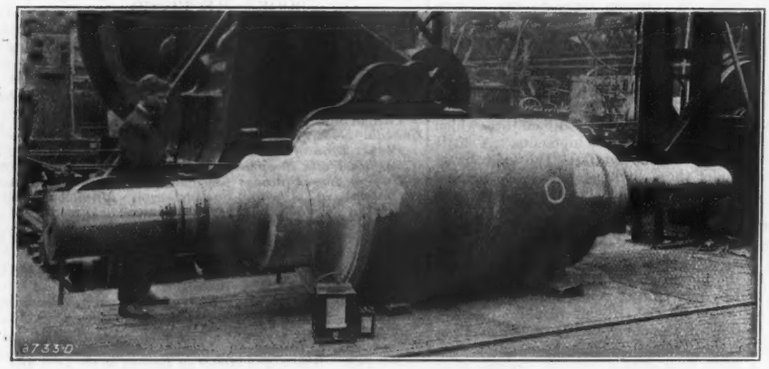


FIG. 4.

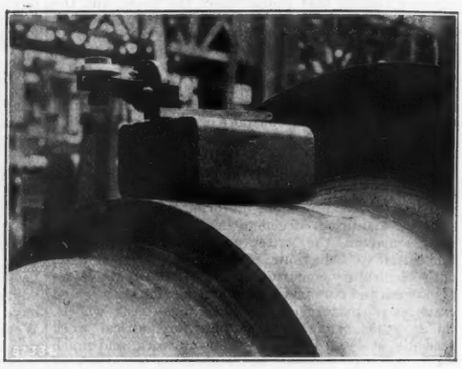


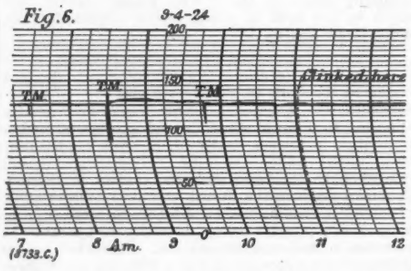
FIG. 5.

THE CAMBRIDGE CLINK DETECTOR.

It is well known that during the heating and cooling processes in the production of steel ingots or forgings severe stresses may be set up, which may attain such value as to cause a fracture in the material. Such fractures are usually accompanied by a severe shock and a ringing noise which can be best described by the word "clink." This sound has hitherto been the only available evidence of such an occurrence rendering the forging defective, and if the fracture should happen during the night, or at any moment when no observer is present or sufficiently alert to report it, the forging may unwittingly be delivered in a very dangerous condition. With the object of minimising this danger, Messrs. C. A. Parsons and Co., Limited, in conjunction with the Cambridge Instrument Company, Limited, have developed an instrument called the "clink detector," which, when attached to a forging during heating and cooling processes, gives an autographic record of any shocks or disturbances which may have taken place. The instrument is sufficiently sensitive to record an ordinary hammer blow, the records being made absolutely trustworthy by arranging for an attendant to give the forging hammer-blows at stated intervals during the period of recording, thus obtaining evidence that the instrument is in working order throughout the period. If the record then shows any shock not accounted for, the forging is rejected as unsound.

The complete outfit comprises two instruments—the detecting instrument, which is attached to the forging under treatment, and the clock-driven recorder, to which the detector is electrically connected. In addition to giving a record of the times of all shocks in the forging, the recorder can be arranged, if necessary, to give synchronous records of the temperatures of the forging.

Fig. 1 shows a diagram of the electrical connections, while Figs. 2 and 3 are sectional drawings of the detector. The instrument comprises a moving system consisting of a brass weight supported horizontally at the extremity of a flat steel spring, carried upon a fixed steel bar, which is either secured rigidly to the forging or attached to a heavy iron block placed upon a suitable portion of the forging. Upon the fixed bar is carried a platinum contact-point, which is adjusted to be normally just in contact with a contact plate carried on the weight. Owing to the inertia of the weight, the occurrence of a clink causes the contacts to open, breaking the electrical circuit, and thus causing a mark to be made on the moving chart in the recorder. The moving system has a long natural period of vibration. From Fig. 3 it will be seen that the upper contact is not directly attached to the end of the adjusting micrometer screw, but is connected by a link. This arrangement enables an accurate adjustment of the contacts to be readily obtained, as the contact does not rotate. Figs. 4 and 5 show the clink detector placed in position on a forging. The instrument is provided with a dust-proof metal cover, as shown in Fig. 4. In Fig. 5 this cover has been removed to show the details of the instrument.



The chart reproduced in Fig. 6 is an actual record of a clink which occurred on an ingot measuring 8 ft. by 3 ft. 6 in. by 2 ft. 3½ in. and weighing 12½ tons. The width of the fracture in the centre was found to be about $\frac{1}{16}$ in. when measured after cutting open for examination after cooling. It will be seen that the clink is very satisfactorily indicated. The duration of the break in the electrical circuit depends upon the magnitude of the impulse, and the marking of the chart, in turn, depends upon the duration of the break. In fact, to some extent, the magnitude of the impulse may be measured by this means. The smaller disturbances shown on the chart are test markings produced by a hammer-blow on the forging at regular intervals. In one or two cases these smaller markings are due to the forging processes, or to heavy weights being dropped in the neighbourhood. These, however, are easily recognisable, and cannot be mistaken for an actual clink.

The clink detector would seem to be an accessory of considerable value to forge masters in increasing the certainty regarding the soundness of forgings. Its use greatly reduces the danger of clinks remaining undetected, and since the instrument can also be adapted for simultaneously recording the temperature of the forging during the manufacturing processes, a valuable written record can be obtained, a copy of which can be handed to the engineer using the forging. This new development in the application of scientific instruments to engineering problems is therefore to be welcomed as giving a much needed confidence in the use of forgings, which in recent years have been increased in size and subjected to increasingly severe conditions of service.

EVIDENCE FOR FATIGUE LIMITS.

*The Evidence for the Existence of an Endurance, or "Fatigue" Limit in Metals and its Determination.**

H. F. MOORE† AND T. M. JASPER.‡

(*Concluded from page* 582.)

The Plotting of the Test Data.—In the investigations carried on in the United States, it has been customary to plot the S–N diagrams either to logarithmic co-ordinates or to semi-logarithmic co-ordinates. The reason for this is two-fold: (1) a logarithmic cycle for the abscissæ makes it possible to plot on the same diagram small values and large values of N with the same percentage degree of accuracy; and (2) in a Cartesian diagram there is some danger that the general tendency towards curvature of the diagram will lead the investigator to assume that an endurance limit has been reached at a comparatively small value of N when such is not the case. Fig. 5, which shows the data of tests on Monel metal plotted into Cartesian co-ordinates (upper), semi-logarithmic co-ordinates (middle), and logarithmic co-ordinates (lower), illustrates this point. The Cartesian diagram would lead the experimenter to report an endurance limit at about 32,000 lb. per square inch. The logarithmic diagram would indicate that the endurance limit had not yet been developed. It is felt that, as long as any common system of plotting shows a straight line relation between S and N, an endurance limit should not be reported.

Endurance Limits of Wrought Ferrous Metals.—For wrought ferrous metals, the results of long-time investigations in the United States offer three items of evidence for the existence of an endurance limit.

(1) The S–N diagrams, even when plotted to logarithmic co-ordinates, become horizontal, or as nearly so as can be determined by ordinary plotting. Usually the horizontal part of the diagram is developed for values of N not greater than two millions. For all wrought

* Read before the Engineering Section of the British Association at Toronto, on August 11, 1924.

† Research Professor of Engineering Materials, University of Illinois, In charge of Investigation of the Fatigue of Metals.

‡ Research Assistant Professor of Engineering Materials, University of Illinois, Engineer of Tests, Investigation of the Fatigue of Metals.

ferrous metals tested, the horizontal part of the diagram was developed for values of N less than ten millions.

Moreover, at the junction of the horizontal part of the S–N diagram and the inclined part there is a fairly well-marked "knee" to the curve. This seems to indicate some change in the law governing the relation of S and N.*

(2) Specimens of metal tested to one hundred million cycles of stress at or near the endurance limit, when retested under cycles of higher stress, have uniformly shown some gain in strength. The evidence is that below the endurance limit as determined from long-time tests, repeated stress actually improves the metal rather than injures it.

(3) For wrought ferrous metals at stresses near the endurance limit there is noted a distinct rise of temperature. This, as has been previously pointed out, is probably not a direct indication of fatigue failure, but is an indication of slip, which usually precedes the formation of a fatigue crack. In a stress-temperature diagram near the endurance limit is a fairly well marked "knee." Below this knee the rise of temperature is very slight indeed. Since for wrought ferrous metals slip seems to precede fatigue fracture, the absence of evidence of slip below the endurance limit as determined by test seems an indirect piece of evidence in favour of the existence of an endurance limit.

It cannot, of course, be dogmatically asserted that for any metal there has been determined a limiting stress below which it is certain that the metal can withstand an infinite number of cycles of stress, but it is felt that the data of long-time tests does show that, for wrought ferrous metals, the assumption of an endurance limit seems reasonably safe, and that such an endurance limit in all probability exists. The existence of an endurance limit for non-ferrous metals is discussed in the succeeding paragraph.

6. *Endurance Limits of Non-Ferrous Metals.*—The data available on fatigue tests for non-ferrous metals are relatively few, when compared with those available for wrought ferrous metals. Mr. R. R. Moore* has made one of the most extensive series of tests in the laboratories of the U.S. Air Service at McCook Field, Dayton, Ohio. The results of these tests indicate that the endurance limit for these non-ferrous metals is not so well defined as is the endurance limit for wrought ferrous metals, and that it is necessary for these metals to carry endurance tests much farther than for wrought ferrous metals.

In the work of the investigation at Illinois, Monel metal, brass, copper, bronze, and a copper-nickel alloy have been studied. Typical S–N diagrams are shown in Fig. 6. The authors of this paper give as a tentative conclusion that for annealed copper and annealed brass an endurance limit is indicated, but that it is not developed until tests have been run to at least one hundred million cycles. For annealed bronze and for Monel metal, no certain endurance limit has been developed, though for the latter tests have been run to about five hundred million cycles. For annealed copper and annealed brass the rise-of-temperature tests indicate endurance limits at about the same stress as given by the S–N diagrams. For Monel metal the rise of temperature test does not indicate any endurance limit below 42,000 lb. per sq. in., which is evidently above any endurance limit which can be given by its S–N diagram.

It should be noted that the S–N diagrams for annealed bronze and for the copper-nickel alloy show considerable "scatter" of points. It seems possible that non-ferrous metals may fall into two divisions, one showing an endurance limit, and one not showing an endurance limit. For the second group it may be necessary to project the line of the logarithmic S–N diagram beyond the available test data and to estimate the unit stress corresponding to any desired life. In this connection it is interesting to note that, based on the limited data then available for steel, Professor Basquin of Northwestern University proposed a similar method for ferrous metals in 1910.

In the non-ferrous metals tested, indications of an endurance limit are obtained for those which can be successfully cold-drawn. This is interesting, but it will be necessary to have many more tests before definite conclusions can be drawn.

Correlation between Endurance Limit and other Test Results.—Long-time fatigue tests of metals are very time-consuming and expensive. It is of very great practical importance to practising engineers to determine, even for special classes of metals, any correlation which may exist between results of long-time fatigue tests and results of the simple physical tests commonly performed. This is especially important in the case of wrought ferrous metals which form by far the most important class of stress-carrying metals. It is believed that for this important class of metals correlations have been reasonably well established between endurance limit on the one hand and Brinell hardness and tensile strength on the other.

One of the objects of the investigation with which the authors are connected was the study of such correlation. Figs. 7 to 12 inclusive, give correlation diagrams for results obtained in the investigation at the University of Illinois for wrought ferrous metals. These figures show respectively the correlation of endurance limit with elastic limit, tensile strength, Brinell hardness, endurance limit as determined by rise of temperature, Charpy impact tests and repeated impact tests upon a special machine.

It is evident that there is no obvious correlation between endurance limit and Charpy tests or repeated-impact tests. In the other diagrams the shaded areas inclosing the observed points give some notion of the degree of correlation—the smaller the shaded area, the better the correlation. It is evident that for wrought ferrous metals the elastic limit is not a very good index of fatigue strength, and that the ultimate tensile strength, the Brinell hardness, and the endurance limit by rise of temperature are fairly reliable indicators of

Fig. 5.

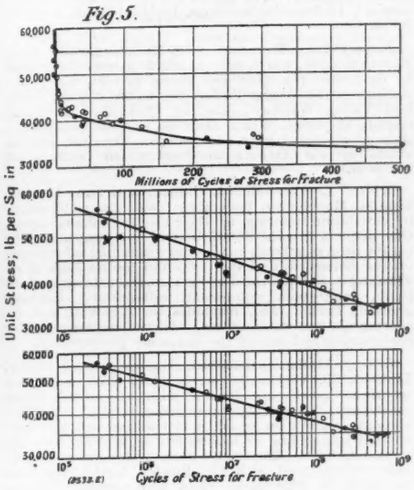


Fig. 6.

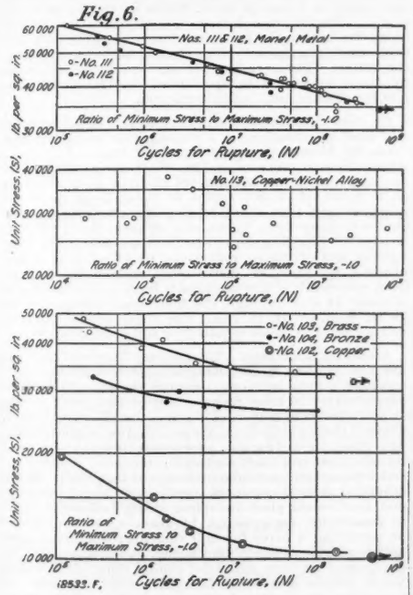
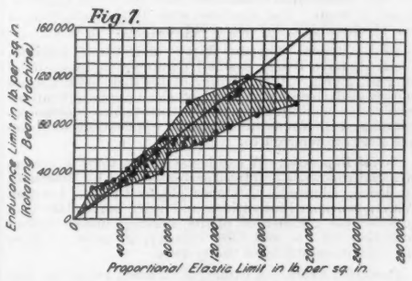
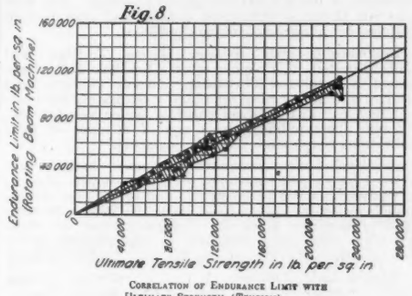

Nos. 111 & 112, Monel Metal
o-No. 111
•-No. 112
Ratio of Minimum Stress to Maximum Stress, -1.0
Cycles for Rupture, (N)
No. 113, Copper-Nickel Alloy
Ratio of Minimum Stress to Maximum Stress, -1.0
Cycles for Rupture, (N)
o-No. 103, Brass
•-No. 104, Bronze
⊙-No. 102, Copper
Ratio of Minimum Stress to Maximum Stress, -1.0
Cycles for Rupture, (N)

Fig. 7.



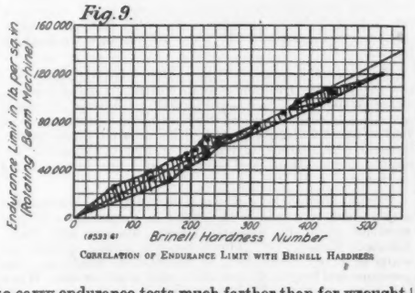
Correlation of Endurance Limit with Proportional Elastic Limit (Tension)

Fig. 8.



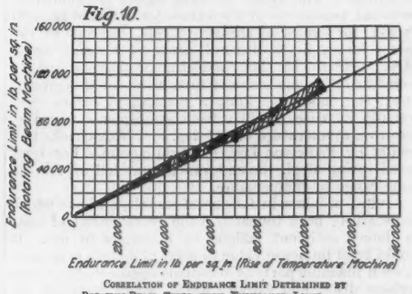
Correlation of Endurance Limit with Ultimate Strength (Tension)

Fig. 9.



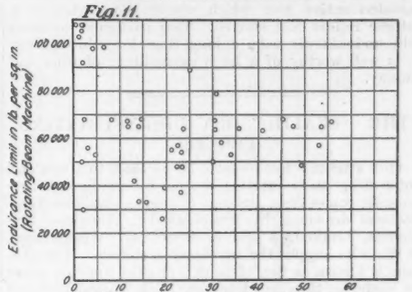
Correlation of Endurance Limit with Brinell Hardness

Fig. 10.



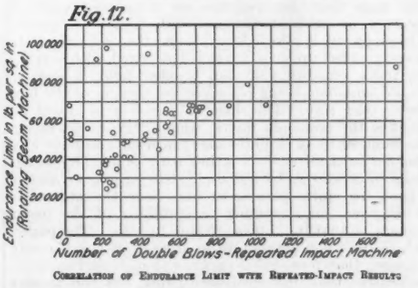
Correlation of Endurance Limit Determined by Rotating-Beam Tests with Endurance Limit Determined by Rise-of-Temperature Tests

Fig. 11.



Correlation of Endurance Limit with Charpy Impact Results

Fig. 12.



Correlation of Endurance Limit with Repeated-Impact Results

* See Proceedings of A.S.T.M., vol. xxii, Part II, page 293 (1922), discussion by L. B. Tuckerman, on the "discontinuity" of the S-N diagram.

* R. R. Moore, "Resistance of Manganese Bronze, Duralumin and Electron Metal to Alternating Stress," Proc. A.S.T.M., vol. xxiii, Part II, 1923.

fatigue strength. It must be remembered that this applies only to metals free from flaws and inclusions. For the wrought ferrous metals studied it would seem that the endurance limit in reversed flexure may be placed roughly at 50 per cent. of the ultimate tensile strength, or at 250 times the Brinell hardness number. So far it has not been possible to get any satisfactory correlation between endurance limits and the above-named physical qualities for non-ferrous metals. In general, the endurance limits determined for non-ferrous metals have been less than 50 per cent. of the ultimate tensile strength, in some cases being as low as 25 per cent.

It may be added that from auxiliary tests at the University of Illinois, the values of endurance limit for other than in reversed flexure, are tentatively placed as follows: For cycles of axial stress (tension-compression), two-thirds of the values for cycles of flexural stress; for cycles of shearing stress, one-half of the values for cycles of flexural stress (test results show 53 per cent.). In this connection it may be further noted that, for one series of tests at elevated temperatures, the endurance limit of normalised carbon steel actually increases slightly from atmospheric temperature to a temperature of 850 deg. F. This checks test results by Professor Lea, of Birmingham. For tempered spring steel, the endurance limit fell off for the same range of temperature.

A vital problem in fatigue of metals, and one which has scarcely been touched, is the development of tests to detect incipient fatigue in materials in use. It would be of immense value to users of metals, especially in such machine parts as aeroplane engine shafts, steam turbine discs, and railway axles, where fractures are especially dangerous, if there could be developed a non-destructive test which would show whether a fatigue failure had started. This particular problem will undoubtedly take a long time for solution, but it is well worthy of a large expenditure of time and money.

THE "OZALID" DRY PHOTO-PRINTING PROCESS.

Our attention has recently been drawn to a new and interesting photo-printing process for producing true-to-scale copies from tracings of engineering and architectural drawings, by Messrs. Cooke, Troughton and Simms, Limited, 3 and 5, Broadway, Westminster, S.W., who supply the necessary materials. The process is known as the "Ozalid" process, and the paper is made in thin, medium or thick substances and also mounted on cotton. It is exposed in exactly the same way as ferro-prussiate paper and for about the same time, but requires no subsequent washing process or other treatment with liquid chemicals. Development is effected by placing the exposed print, loosely rolled up, in a wooden box fitted with a tray, or trays, consisting of thin wooden laths, a dish of liquid ammonia being placed in the bottom of the box below the tray. The door of the box is closed to confine the ammonia fumes, which develop the image in from 10 to 15 minutes and the result, without any further treatment, is a print with practically black lines on a whitish background. The prints, we understand, are quite permanent and since the process is a dry one, no stretching or shrinking of the paper occurs, so that the copies are true-to-scale. The paper, which does not deteriorate in storage, is considerably cheaper than ferro-gallic paper, although slightly more expensive than ferro-prussiate paper, but the makers claim that, owing to the saving of time and labour in connection with the washing and drying operations, it is possible to produce the "Ozalid" true-to-scale prints at about the same cost as ordinary blue prints. For making corrections on the finished prints, lines can be removed by a solution of hypochlorite of soda or a 5 per cent. solution of permanganate of potassium.

Reduction in Laid-up Merchant Tonnage.—According to returns issued by the Chamber of Shipping a very material reduction in the British and foreign merchant tonnage laid up in the principal ports of Great Britain and Ireland has taken place during the quarter ended October 1 last. Considering only vessels of 1,000 tons and upwards, the net tonnage idle on October 1 was 333,810 as compared with 470,073 tons on July 1 of this year, and with 755,101 tons on October 1, 1923. The reduction of 136,263 tons which has been effected during the last quarter, thus amounts to 29 per cent., and the idle tonnage is now only about 44 per cent. of the figure for the same time last year. The decrease has been general at most of the ports of the country, although the coal-exporting ports of Cardiff and Swansea are exceptions to this rule. At Cardiff the idle tonnage increased during the last quarter from 5,248 net tons to 14,075 net tons, and the increase at Swansea has been from 2,833 net tons to 13,914 net tons. In general, however, the figures are evidence of a distinct improvement in the freight markets, and may be taken as an indication that the shipping industry is now emerging from the depression through which it has been passing.

CATALOGUES.

Electrical Supplies.—The British Insulated and Helsby Cables, Limited, Prescot, Lancs., have sent us a small bound pocket edition of their general catalogue, which will be useful for preliminary reference as it contains many illustrations, dimension tables, &c., as well as other information.

Oxy-Acetylene Welding Plant.—An acetylene generator mounted on a portable stand, a welding set including a generator and stands for gas cylinders on a three-wheeled truck, and welding and cutting blow pipes are illustrated in a leaf catalogue received from Messrs. Matthews and Yates, Limited, Swinton, Manchester.

Coal-Cutting Machines.—In the 11th edition of their catalogue of coal-cutting machines, Messrs. Mavor and Coulson, Limited, 47, Broad-street, Mile End, Glasgow, describe three types of machine with the latest improvements in each. The machines were fully dealt with in our 115th volume, on pages 615 and 648.

Steel.—Messrs. Thomas Firth and Sons, Limited, Sheffield, have issued a small pamphlet of exceptional interest, giving a brief history of the firm with a series of views of their works, and of the various operations involved in making special steels, cutting files, machining, grinding, &c. Numerous industrial applications of stainless steel are referred to.

Aerial Ropeways.—A catalogue of the Ceretti system of aerial ropeways and transporters, issued by Messrs. E. L. Price, Limited, 6, Upper Bedford-place, London, W.C.1, contains illustrations and brief particulars of a considerable number of plants working under various conditions in flat and hilly country, in order to show the wide adaptability of the system.

Reduction Gears.—A catalogue of worm reduction gear units, to hand from Messrs. Crofts (Engineers), Limited, Thornbury, Bradford, illustrates a comprehensive range of standard sizes in closed and open housings, with examples of units made for special purposes. The firm also cut all forms of toothed gearing and manufacture clutches for power-transmission purposes.

Reinforced-Concrete Bridges.—Messrs. Trollope and Colls, Limited, 5, Coleman-street, London, E.C., have issued a catalogue illustrating several viaducts and bridges and giving rules for roughly estimating the costs per foot run in reinforced concrete under average conditions. This publication is one of a series of brief collections of reference data for engineers.

Machine Tools.—Sectional catalogues dealing with crank-type shaping machines, tool-room shapers, slotting machines up to 26 in. in stroke, and single and duplex puncher slotters are to hand from the Butler Machine Tool Company, Limited, Halifax. Some of these machines have been described in our columns in the recent series of articles on the Machine Tool Exhibition.

Electric-Light Fittings.—A list of reflectors, lamps, wall and other brackets, received from Messrs. Veritys, Limited, Aston, Birmingham, includes a very comprehensive range of these articles with dimensions and prices. Intensive and dispersive reflectors and angle reflectors for indoor lighting, fittings for street lighting and a number of weather-proof lanterns are amongst the leading items.

Waste-Heat Boilers.—A pamphlet of importance to owners of industrial concerns in which hot gases are discharged to waste has been issued by Messrs. Cochran and Co., Limited, Annan, Scotland, who make vertical boilers specially suitable for utilising such waste gases. Several illustrations are given of boilers supplied for raising steam from the waste heat from forges, steel works, &c.

Textile Machinery.—A warp-damping mechanism for attachment to looms is described in a special catalogue received from the makers, Messrs. Mather and Platt, Limited, Manchester. The damper is swung against the warp at every revolution of the bottom shaft, and the pressure and length of time of contact is adjustable. When the loom is stopped, the damper is always left in the "off" position.

Motor Starters.—Two catalogues dealing, respectively, with hand-operated, three-phase, auto-transformer starters for squirrel-cage induction motors and alternating-current contactor-control equipments for reversing polyphase slip-ring motors are to hand from the British Thomson-Houston Company, Limited, Rugby. Both present very complete technical and commercial particulars, with priced lists.

Screwing Machines.—A catalogue to hand from Messrs. Joshua Heap and Co., Limited, Ashton-under-Lyne, contains illustrations and descriptions of five standard screwing machines, working to maximum diameters up to 4 in. The die head is self-opening and the dies are serrated blades tangentially disposed within the head. The die-head revolves and the work is held in a vice fixed to a sliding saddle.

Metals.—We have received eight little pamphlets, each containing a considerable amount of information on the subject of nickel and cobalt and various alloys, from Messrs. Henry Wiggin & Company, Limited, 55, George-street, Birmingham. The characteristics and uses of these materials are explained in clear general terms, with technical data which will be of value to the managers of various industrial concerns.

Fire Bricks.—Signor G. Verzocchi, Milan, Italy, has issued a catalogue of firebricks, in which he conveys the necessary practical and technical information by means of illustrations, with a few words in Italian in each case. The book should certainly fulfil Signor Verzocchi's aim, which, he states, is "to give to fire-brick consumers something which will not be thrown into the waste-paper basket."

Oil Engines.—Messrs. Ruston and Hornsby, Limited, Lincoln, have sent us a new catalogue of vertical oil engines of the four-cycle, airless injection, cold-starting type for using low-grade fuel. The list of standard sizes includes 18 engines having from one to six cylinders, and developing from 17 b.h.p. to 825 b.h.p. A number of illustrations of engines installed for generating electric current, and some useful technical data are also given.

Diesel-Engine Locomotives.—A catalogue of Diesel-engine locomotives, received from the Graz Railway Carriage, Wagon and Engine Works, Vienna, contains a description of locomotives of this type made by the firm, with an account of tests of an engine designed for shunting and yard service on the London and North Eastern Railway. The agents are Messrs. W. Dederich, Limited, 18 Imperial-buildings, Ludgate-circus, London, E.C.4.

Power Plant.—The issues of the *Bulletin Oerlikon* from May to August, which have reached us, contain articles on the tests of a 3,000 kw. steam turbine, the power stations of the Wæggi Valley, the motor coaches of the Sihl Valley Railways, the El Charquito generating station, Colombia, South America, and several descriptions of electrical gear and pumps. The bulletins are issued by the Ateliers de Construction Oerlikon, of Oerlikon.

Miners' Lamps.—Messrs. Oldham and Son, Limited, Denton, Manchester, have three catalogue publications in circulation relating to their electric miners' lamps. One gives a general description of the lamps, another (in the form of a house magazine) containing information on the construction of the lamp and the methods of recharging it, and the third being a general catalogue of the lamp, lamp-room equipment, cell-cleaning machine, charging frame, rack, machines for removing and replacing glasses, cleaning, &c. All the requirements for maintaining and issuing the lamps are provided for.

Lifting Machinery.—Messrs. Ransomes and Rapier, Limited, 32, Victoria-street, London, S.W., have sent us three catalogues dealing with specialised lifting machinery. One of the catalogues relates to a four-column erection on which a locomotive can be lifted, so that unwheeling or repairs can be effected from the workshop floor. The second deals with a series of dock-side cranes fitted with the Bowtell level-luffing gear, mounted on wide gauge rails, and capable of lifting such loads as 3 tons at 60 ft. radius or 10 tons at 50 ft. radius. The third catalogue illustrates a transporter crane for dealing with town refuse and employing two tubs which are carried on an electric lorry for collecting the refuse. These catalogues are worthy of attention by those interested in specialised machinery for promoting efficient and rapid transport.

Printing Machine.—We have received an illustration and brief specification of a newspaper-printing machine made by Messrs. Joseph Foster and Sons, of Preston, whose London office is at 134, Fleet-street, E.C. This machine will print newspapers of from 4 to 16 pages at a speed of 32,000 copies an hour, or of up to 32 pages at half that speed, folding them to half-page size and delivering them in counted quires; two different devices for inserting stop-press news are described. The various sets of inking rollers can be lifted clear of the printing cylinders or distributing surface by a single lever movement. The machine is built in four decks and is about 14 ft. 6 in. high, the floor space occupied being 26 ft. 6 in. by 10 ft. 7 in. The total weight is about 44 tons and the power required for full work about 55 h.p.

Electrical Machinery.—The General Electric Company, Limited, Magnet House, Kingsway, have sent to us eight catalogues, new editions recently issued, which show very clearly the large range of engineering work carried on by this company and its associated organisations. Three of these publications are sectional catalogues dealing with direct current motors, alternating current motors, and transformers and each containing technical descriptions and commercial particulars relating to the plant. Of the others, a general catalogue deals with heavy electrical and mechanical plant including steam turbines coupled to generators, compressors, blowers or other machines or providing a drive for mill shafting; colliery engines and motors for winding, ventilating, haulage, etc.; power equipment for iron and steel rolling mills, shipbuilding yards, textile and other factories; complete plant for conveying coal, ore and other materials; and the necessary switchboards, starters and other electrical gear. Four other catalogues deal more exhaustively with turbo plant, steam and electric winding engines, conveying plant and Fraser and Chalmers concentration machinery, respectively.

Refuse Destructors.—The economy of steam generation in refuse destructors is frequently so low that fuels are added to the refuse. The risk then arises that the fuel is not properly burnt in the destructor. At Schöneberg, one of the suburbs of Berlin, the Martin cascade grate for refuse destructors has given satisfaction. The grates are designed for low grade coal and seem to be able to deal with it. The chief advantage of adding coal to the refuse is perhaps that a fairly uniform heat supply can be secured, independent of the seasonal and diurnal fluctuations in the supply and quality of the refuse. The working of the Schöneberg destructor is very simple. One grab takes up both the refuse and the coal as desired and drops them into the furnace hopper; the slag obtained is said to be suitable for building purposes.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACTS OF 1907 AND 1919.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the communicators are given in italics.

Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 1s.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

AERONAUTICS.

217,031. The Fairey Aviation Company, Limited, Hayes, Middlesex, and F. R. Fairey, Hayes, Middlesex. Rudders of Aeroplanes. (4 *Figs.*) May 29, 1923.—The object of the invention is to increase the effectiveness of the rudder when, the angle of attack being high, the speed of advance is reduced and the difficulty of steerage becomes consequently greater. For this purpose, according to the invention, the rudder-axis is so arranged as to rake upwards and forwards when the machine is on a level keel, the inclination being such that when the machine is advancing at high angles of attack the axis will assume a position substantially normal to the direction of flight. In contrast with the common arrangement

Fig. 1.

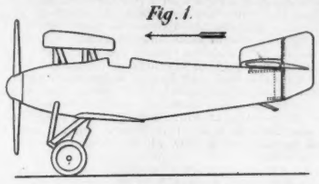


Fig. 2.

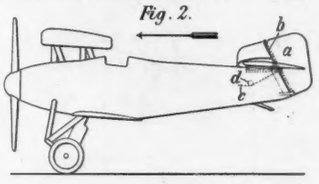
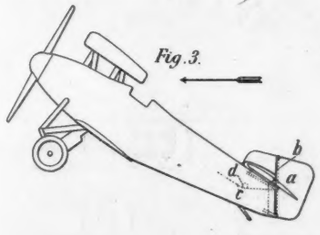


Fig. 3.



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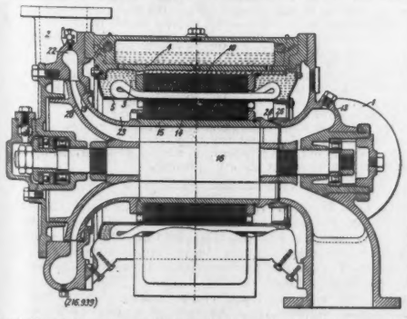
illustrated in Fig. 1, the rudder *a* is movable about an axis *b* which is inclined to the direction of flight upwardly and forwardly at an angle of about 30 deg. (more or less) when the machine is on a level keel as in Fig. 2, but which is approximately perpendicular to the direction of flight when the machine is advancing at a high angle of attack as in Fig. 3. The cables *c* whereby the rudder is actuated are preferably so guided, as indicated for example at *d* (Figs. 2 and 3), as to extend, from their points of attachment to the usual rudder-levers, in a plane substantially normal to the rudder-axis *b*, so that a pull transmitted through either cable may act upon the rudder with the maximum effect. (*Sealed.*)

ELECTRICAL APPARATUS.

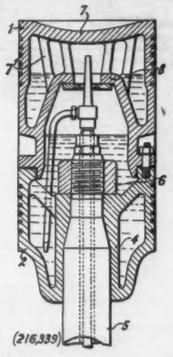
216,939. T. L. R. Cooper, Westminster, London. Combined Electric Motors and Pumps. (3 *Figs.*) March 6, 1923.—The invention relates to combined electric motors and



centrifugal pumps. According to the invention, the enclosed stator coils and laminations, together with the rotor laminations, are cooled entirely from within the machine by means of cooling water supplied directly from the pump impeller into the rotor chamber. The pump intake is shown at 1 and the delivery outlet at 2. The electric motor is of the type having the stator coils entirely enclosed in a water-tight chamber 3 filled with an insulating fluid. The water-tight chamber 3 is enclosed between the cylindrical casting 4 of the stator and a thin cylinder 5. The stator polar laminæ 10 are secured in the casting 4. The rotor laminæ 14 are secured upon a sleeve 15 which is held at its ends co-axial with the shaft 16 of the machine. In order to effect the cooling of the operative elements of the electric motor, the shaft 16 is maintained in such a position relatively to the casing 13 that an inclined interval or gap 19 is formed between the pump impeller 20 and the wall of the pump volute 22, enabling a constant flow of cooling water to be supplied from the impeller through the gap 19 into the rotor chamber 23. This cooling water is in contact with the part 5 forming the enclosure of the watertight chamber 3 containing the stator coils, and also with the rotor laminations 14, and returns to the suction end of the pump through another gap or interval 24 between the suction end of the rotor sleeve 15 and the adjacent part 26 of the casing 13.—(*Sealed.*)

GAS ENGINES, PRODUCERS, HOLDERS, &c.

216,339. Wallsend Slipway and Engineering Company, Limited, Wallsend-on-Tyne, and J. S. Simm, Monkseaton. Pistons and Piston Rods. (1 *Fig.*) May 28, 1923.—The invention relates to the construction of pistons and piston rods of internal-combustion engines. The piston, according to the invention, comprises two hollow parts 1, 2 bolted or studded together end to end to enclose between them a cavity, distance pieces being interposed, if desired, between said parts to vary the overall length of the piston. The inner part 2, which alone is

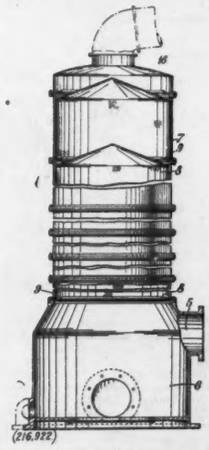


(216,339)

connected to the piston rod 5, is provided with a central boss 4 which is connected at the upper and lower ends only to the cylindrical wall which carries the piston rings. The internal bore of the boss 4 is reduced in diameter at the upper end to form a female truncated cone for reception of the piston rod 5 which is inserted from the lower end and secured by a nut 6 at the upper end. The outer part 1 has a crown 7 and a lower flange 8 connected by ribs 7^1, which are preferably radially disposed and are neither interconnected nor connected to the cylindrical wall which carries the piston rings.—(*Sealed.*)

MINING, METALLURGY AND METAL WORKING.

216,922. F. Lamplough, Feltham. Treatment of Hydrocarbon Oil Vapours. (4 *Figs.*) March 1, 1923.—Vapours obtained in the cracking of oils or the distillation of oil-bearing material, such as shale, are gradually cooled and the uncondensed vapours are intimately mixed with the condensates obtained at each stage of the cooling. By this means the yield of saturated liquid hydrocarbons is increased, and the yield of unsaturated hydrocarbons and free hydrogen is diminished. The vapours at a temperature of about 400-430 deg. C. enter through an opening 5 into the lower chamber 6 of a tower 7 which contains superposed bells 8 having perforated side walls and closed conical



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tops. The bells rest upon gutters 9 shaped so as to cause the condensates to flow over the interior wall of the tower. The vapours pass through the perforations and impinge against the descending condensates. They are directed by the gutters to the inner part of the bell above. The chamber 6 may contain a coil through which the hot vapours pass to vapourise light oils from the condensates. A series of towers may be used to cool the vapours to 150-200 deg. C. The uncondensed vapours pass from the top through a pipe 16 to a scrubbing condenser through which they pass downwards. The condenser is in the form of a tower having a cooler at the top and below it a series of perforated bells, the gutters between which are formed so as to direct the condensates on to the top of the bell below. The uncondensed gases are withdrawn from the condenser by a pipe which projects upwards into a second pipe depending from the inside of the bottom bell. (*Sealed.*)

215,452. J. S. Highfield, London, and W. E. Highfield, London. Welded Joints. (4 *Figs.*) February 10, 1923.—The invention has for its object the protection of welded joints in metal pipes where forces are in existence tending to tear the welded joint apart. The invention consists in protecting welded joints in metal pipes and in carrying it out an apertured sleeve piece is placed over a welded joint at the meeting ends of the pipes whereupon the sleeve piece is welded through the apertures

Fig. 1.

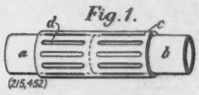
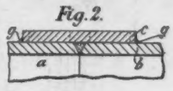


Fig. 2.

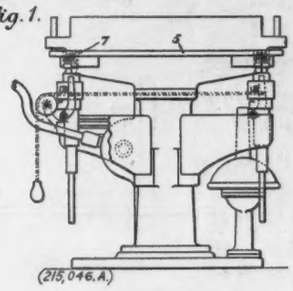


(215,452)

therein and along its edges to the pipes. *a* and *b* denote parts of two pipes to be connected together, and *c* is a sleeve piece which has longitudinal slots *d* or holes, the slots and holes being preferably tapered. The sleeve piece *c* being placed in position over a joint between two pipes *a* and *b*, an electric arc or other suitable form of welding apparatus is used to fill more or less the slots *d* or holes with welding metal, the metal being welded to the pipes and to the sleeve, which is also welded along its edges at *g*. (*Sealed.*)

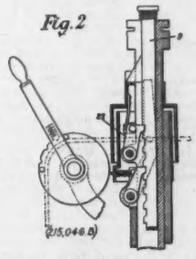
215,046. J. Cash, Horseley Heath, Tipton. Foundry Moulding Machine. (3 *Figs.*) January 4, 1923.—The invention has reference to means for supporting the moulding box or pattern plate of a foundry moulding machine in the raised position when it is desired to remove the pattern therefrom or for other purposes. The invention consists of means for supporting the moulding box or pattern plate of a foundry moulding machine and consists of a plurality of rods 9, which

Fig. 1.



(215,046.A.)

Fig. 2

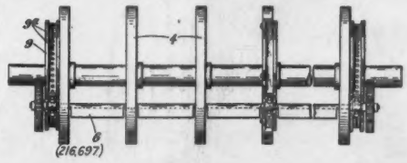


(215,046.B.)

are vertically slidable within and through the moulding plate or table 5, the rods being automatically maintained in their raised position by means of catches 22 when the rods are raised, the upper ends of the rods being disposed within recesses 7 formed in the moulding plate or table in such a manner that they always form part of the support of the moulding box or pattern plate, even during the ordinary ramming operations of the moulding machine. (*Accepted May* 14, 1924.)

PRINTING AND ALLIED MACHINERY.

216,697. H. G. Rogers, South Lambeth. Folding Mechanism. (4 *Figs.*) June 6, 1923.—The invention has relation to folding mechanism for printing machines of the kind comprising a folding knife mounted on, and with its axis parallel with the axis of, a rotary cylinder in relation to which it is adjustable circumferentially, the knife being rotated by rack and pinion mechanism mounted on the adjacent machine framing and on the



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spindle of said knife, respectively, and is thereby caused to extend beyond the periphery of the cylinder. In accordance with the invention, the cylinder 4 has at its ends and externally thereof grooved flanges 9 in which the bearings for the knife 6 are received, said flanges being provided in the grooves with spaced holes 9a to receive the bolts which secure the knife bearings and permit of their adjustment circumferentially of the flanges. (*Accepted June* 12, 1924.)

RAILWAYS AND TRAMWAYS.

216,824. F. S. Roberts, Ellesmere, and W. H. Evans, Ford, Shrewsbury. Door Locking Apparatus. (13 *Figs.*) February 26, 1924.—The doors of railway carriages are automatically locked and unlocked by centrifugal means actuated by rotation of a carriage axle. Blocks E are freely mounted on spindles D secured to the axle by a collar C and are pressed towards the axle by springs F^1. A bracket A^1 on the carriage frame supports a spindle B having cross bars B^2, B^3 extending at right angles to one another and a crank arm B^1 parallel to

the cross bar B^2. The arm B^1 is connected by a universal joint G to a rod H pivoted to a short arm J^1, Fig. 2, fixed to a shaft J, and the shaft J carries crank arms K extending in opposite directions at each side of the carriage. Pins on the arms K engage V-shaped slots L^2 in rods L connected by levers M to locking bolts P. As the axle rotates the blocks E^1 move outwardly and one contacts with the cross bar B^2 and turns it through 90°, whereby the rod H is pushed forward, causing the pin on the arm K to move upwardly in the V-slot and draw the rod L towards it, thus shooting the bolt. When the

Fig. 1.

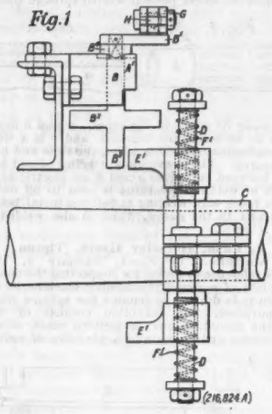

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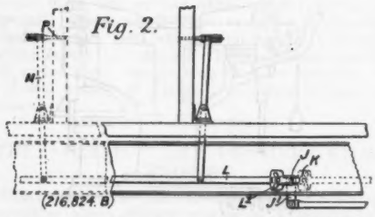
Fig. 2.



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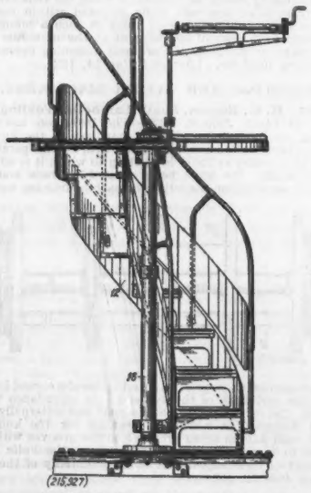
speed is reduced the blocks E^1 move inwardly and one of them comes in contact with the bar B^5, turning the spindle through a second 90° to withdraw the bolt. The action is repeated when the train again starts, but if it moves in the same direction as before the crankarm B^1 is moved through the third sector and the pins on the arms K move downwardly in the V-slot. The bracket A^1 has two grooves at right angles on its top face to receive corresponding projections on the head B^4 of the spindle B. The bolts P are rounded and spring-pressed to allow closing of the doors after the bolts are shot. (*Accepted June* 12, 1924.)

215,927. E. G. Walker, Hendon, London, and The Metropolitan Electric Tramways, Limited, Westminster, London. Staircases for Passenger Vehicles. (7 *Figs.*) April 16, 1923).—The invention is for improvements in staircases for passenger vehicles of the type of vehicle in which the passengers ascend to and descend from the upper deck by a staircase forming part of the vehicle. According to one feature of the invention, there is provided a passenger vehicle of the type described which is characterised by the employment of a staircase 12 mounted to be adjusted rotatively about a vertical pivot 16 to present its face in different directions relatively to



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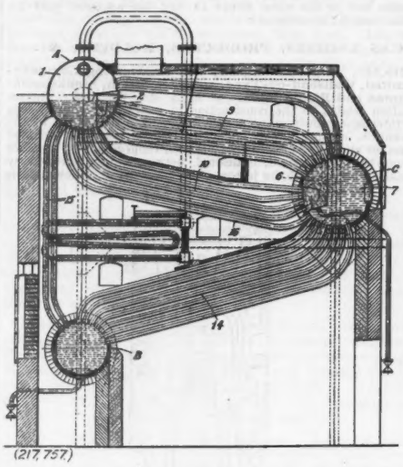
the vehicle. Conveniently, reversible passenger vehicles, such as tramcars, are provided at each end with a rotary staircase 12 which is adjustable to face either side of the vehicle as desired. Thus, both of the staircases may be turned to face the near side of the vehicle, whichever way it is travelling, and passengers permitted, say, to enter at one end of the car and leave at the other end of the car. This will speed-up the loading and unloading of the car, not merely because it will provide two staircases for the purpose, but because it will tend to obviate the usual crowding of the passengers around a single staircase which has to be used both by passengers entering the car and those alighting from it. Reversible tramcars usually, of course, have two staircases, but these are fixed, and one of them is always facing the off-side of the car, and, consequently, cannot safely be used. The present invention, therefore, while occupying no more room than is occupied by existing constructions of staircases, permits them both to be put to useful purposes all the time.—(*Sealed.*)

STEAM ENGINES, BOILERS, EVAPORATORS, &c.

217,757. A. Elliott, Chelsea. Water-tube Steam Generators. (1 *Fig.*) June 6, 1923.—A water-tube steam generator, in accordance with this invention, comprises a steam and water drum A and two water drums B, C disposed at the corners of a triangle and connected with one another by banks of tubes with the steam and water drum A situated at the rear of the steam generator and above the water drum B. The steam and water drum A and the water drum C, which is situated at the



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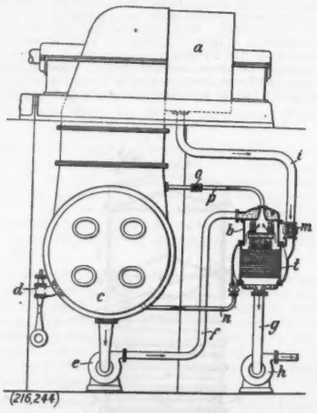
front of the steam generator, being each divided into two separate compartments, of which the two compartments 1, 2, of the steam and water drum A are connected with the compartment 6 of the drum C by two banks of tubes 9, 10, the compartment 7 of the water drum C being connected by banks of tubes 14, 16 with the water drum B and with the compartment 1 of the steam and water drum A. The compartment 1 is further connected by a row or rows of tubes 15 with the water drum B. (*Sealed.*)

216,244. H. Fothergill, Westminster, London. Boiler Feed Water Supply Plants. (1 *Fig.*) September 3, 1923.—The invention relates to steam turbine plant in which means are provided for removing the air from the boiler feed water by heat treatment in a vessel generally called a deaerating apparatus. *a* is the main turbine, *b* the deaerator and *c* the main condenser, from which the air is removed by the ejector *d*. The pump *e* removes the condensate from the condenser *c* and discharges through the pipe *f* into the deaerator *b* from which the deaerated water is removed through pipe *g* by the pump *h*. Low-pressure steam is bled from the turbine through the pipe *l* under control of the valve *m*, and is used in the tubes *t* for raising the water to the desired temperature. *n* is a drain connection



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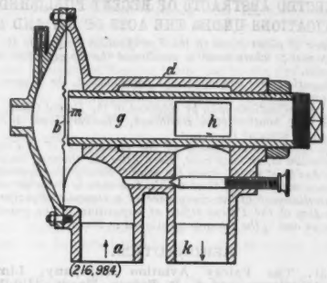
through which the condensed steam from the tubes is discharged into the condenser *c*. The deaerator *b* is maintained under vacuum by placing it in communication with the condenser *c* by way of the pipe *p*. This pipe *p* is provided with a nozzle *o* for the purpose of limiting to a predetermined amount the quantity of aerated vapour passing from the deaerator *b* to the condenser *c* by the choking effect of the device *o*. Any restricted opening in the pipe *p* will give this desired effect, and, in the arrangement shown, an ordinary valve is illustrated. By the use of this restricted opening the pressure in the deaerator is maintained at that corresponding to the temperature of the water therein, while a predetermined amount of aerated vapour is continuously discharged through the pipe *p*. (*Sealed.*)

216,984. R. L. Roxburgh, Newcastle-upon-Tyne. Gas-fired Steam Boilers. (2 *Figs.*) March 29, 1923.—The invention relates to steam-pressure controlled gas valves for automatically regulating the pressure in all kinds of gas-fired steam boilers and heating apparatus by controlling the supply of gas to the burners. A steam-controlled gas valve, in accordance with the invention, is provided with means for externally regulating the diaphragm-controlled gas outlet relatively of the diaphragm *b* to suit the varying requirements of the apparatus to be heated, said means being independent of the gas inlet pipe *a* and gas outlet pipe *k* of the valve and comprising a tube *g*, one end, *m*, of which co-acts with the diaphragm *b*, and the other end is sealed and extends to the outside of the valve casing *d* where it is provided with means whereby it can be rotated.



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The tube *g* is perforated at *h* to allow the gas to pass to the gas outlet *k* and is threaded so that rotation causes it to approach or to be retracted from the diaphragm *b*. (*Sealed.*)

MISCELLANEOUS.

214,416. John Fowler and Co. (Leeds), Limited, Leeds, and D. Wood, Yeadon, near Leeds. Road Scarifiers. (2 *Figs.*) March 20, 1923.—The invention relates to scarifiers for roads and similar surfaces of that type which are provided with inclined tynes rotatable about their axes to act in the manner of drills, and mounted on a road roller in an adjustable frame so that the tynes may be raised and lowered in relation to the ground. The invention comprises a novel combination of parts comprising one or more inclined axially rotatable tynes acting in the manner of drills, the tyne or tynes being mounted on the vehicle with part of the driving mechanism as a self-contained adjustable unit and having means for rotating same from a road wheel of the vehicle, with clutch mechanism embodied in the transmission means for putting the tyne or tynes into or out of operation at will. *a* designates a road wheel of a vehicular scarifier and *b* the rear frame. On the axle of the road wheel is mounted a gear wheel *c* which meshes with a pinion *d* on a stub shaft *e* extending from the frame *b*. On the stub shaft *e* is also a sprocket *f* and between the latter and the pinion *d* is a dog clutch *g* operable by means of a lever *h* at the

Fig. 1.

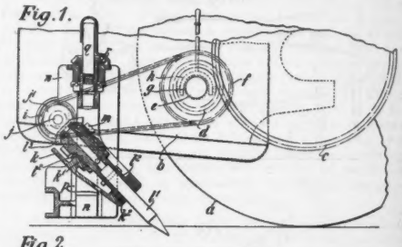


Fig. 2.

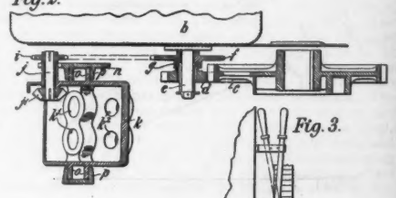
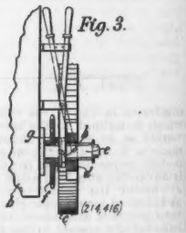


Fig. 3.



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side of the frame, so that the drive to the sprocket *f* can be brought into or out of action at will. The sprocket *f* is connected by a chain to another sprocket *i* mounted on a stud shaft *j* carried by a frame or casting *k* at the rear of the vehicle, this casting being provided, as shown in Fig. 2, with interior apertures forming journals k^1, k^2, in which the tynes can rotate, provision being made for two tynes side by side. The tyne illustrated in Fig. 1 comprises the spike l^1 pinned to a sleeve l^2 having bearing in the journals k^1, k^2 the rear end of the sleeve l^2 terminating in a bevel wheel l^3 with which meshes a bevel wheel j^1 on the stub shaft *j*, so that rotation of the latter imparts axial rotation to the tyne. Where two or more tynes are provided, rotation of one is imparted to the next in opposite direction by means of intermeshing spur wheels, one of which is shown at *m* on the sleeve l^2. The tynes can be raised and lowered at will, as by mounting the casting *k* in a bracket *n* extending downwards at the rear of the vehicle, the casting being provided with extensions *o* working in guides *p* in the bracket and the whole unit being operated by a screw spindle *q* and rotatable nut *r* in the form of a bevel wheel driven by any convenient means, not shown. (*Sealed.*)

12-Ton Hopper Wagons.—We understand that the Cambrian Wagon Company, Limited, of Cardiff, have recently delivered to the Glasgow Corporation a number of 12-ton hopper bottom door wagons for coke traffic connected with the Corporation's Dawsholm gasworks. These wagons have wooden frames. The two bottom doors can be opened and closed independently, and the discharge regulated as required by the operation of handwheels on both sides of the vehicle. There is no need for men to go under the wagon to close the doors, and the rate of discharge at one point is said to be of the order of 350 tons per hour.